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NON-AQUEOUS SOLUTIONS[1]

By Professor CHARLES A. KRAUS

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I. INTRODUCTION

I HAD hoped to discuss the chemical, as well as the physical, properties of non-aqueous solutions, but upon further consideration, it became clear that any such discussion would necessarily consume far more time than I have available on this occasion. I shall, therefore, limit my discussion to the physical properties of non-aqueous solutions and, indeed, to the physical properties of solutions of electrolytes. I shall first consider the influence of the physical properties of the solvent medium upon the properties of the solutions and, thereafter, I shall discuss the influence of constitution of the electrolytes upon the properties of their solutions.

[1] Address of the president of the American Chemical Society, Boston, September 14, 1939.

II. PHENOMENA DEPENDENT UPON SOLVENT PROPERTIES

Solubility. The solubility of ordinary, inorganic salts is chiefly determined by the chemical nature rather than by the physical properties of the solvent medium. The dielectric constant of the solvent is of secondary importance as a determining factor of the solubility in the case of ordinary, inorganic salts. Many inorganic salts, for example, are readily soluble in ethylamine, whose dielectric constant is 6.2, while there are few, if any, that are readily soluble in nitrobenzene, whose dielectric constant is 35.

The solubility of salts is of great importance in the study of solutions of electrolytes. In order to investigate the phenomena of electrolytic solutions broadly, it is necessary to dissolve a given electrolyte

in a wide variety of solvents. This may be accomplished by using suitable substituted onium salts. By introducing long hydrocarbon chains into the positive ions of onium salts, it is possible to obtain electrolytes that are soluble in practically all liquids at ordinary temperatures, even in the saturated hydrocarbons.

Influence of Dielectric Constant. In order to get a picture of electrolytic solutions from a broad point of view, it is necessary to examine the properties of solutions of a typical strong electrolyte in a great variety of solvents. There are, perhaps, no experimental observations that serve this purpose more effectively than the conductance measurements of Dr. Fuoss with mixtures of dioxane and water. With these mixtures, it is possible to work with a solvent medium whose dielectric constant may be varied continuously between 78.6, that of water, and 2.2, that of dioxane. In Fig. 1 are plotted values of the logarithms of equivalent conductance, as ordinates, against the logarithms of concentration, as abscissas, for solutions of tetra*iso*amylammonium nitrate in dioxane-water mixtures. Logarithms are employed in order that all the data may be brought together in compact form; the equivalent conductance varies over a range of 1 to 1,000,000 and the concentration over a range of 1 to 100,000.

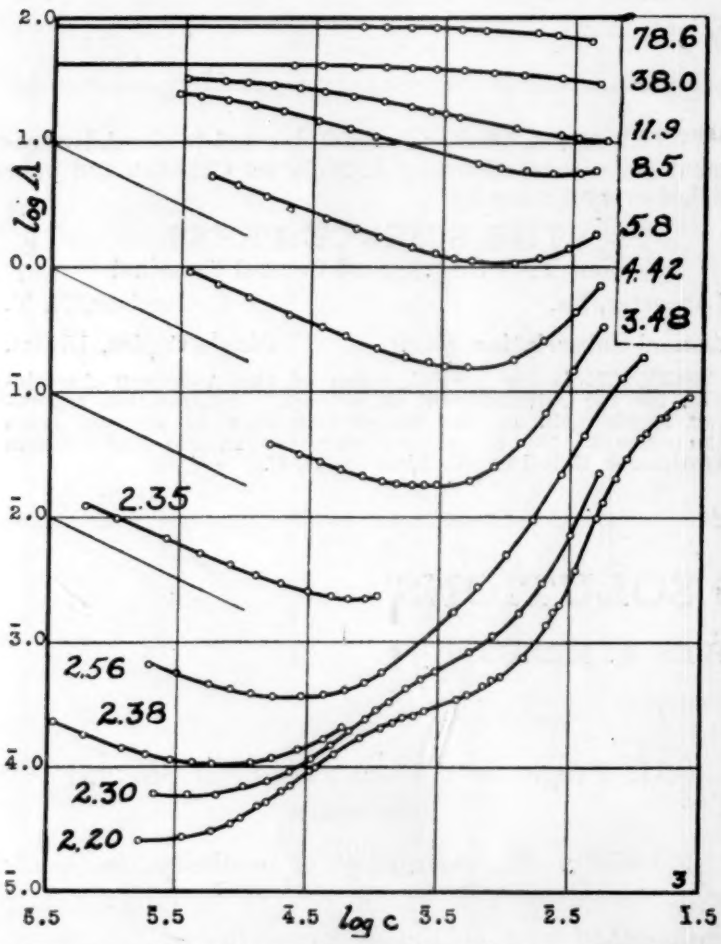

FIG. 1. Conductance of tetra*iso*amylammonium nitrate in dioxane-water mixtures.

I shall not attempt interpretation of the experimental results illustrated in the figure at this point, but the figure will serve to show the character of the phenomena with which we have to deal in solutions in non-aqueous solvents generally. Whether the two solvents be water and dioxane, or whether they be two other miscible solvents of widely differing dielectric constants, and whether the electrolyte be tetra*iso*amylammonium nitrate or some other salt, the general character of the conductance curves will closely parallel those of the figure just shown. We are clearly dealing with phenomena of perfectly general nature in which the dielectric constant of the solvent medium plays a predominant role.

Solvents of High Dielectric Constant. In solvents of high dielectric constant, such as water, typical strong electrolytes are completely dissociated into their ions and the properties of such solutions are accounted for in satisfactory manner by the ion atmosphere theory of Debye and Hückel and Onsager. According to this theory, there is a residual interaction between the ions, due to Coulomb forces, even though the solutions may be quite dilute. According to the theory, the equivalent conductance of an electrolyte should vary as a linear function of the square root of the ion concentration which, in the case of a completely dissociated electrolyte, is proportional to the total salt concentration. In Fig. 2 are plotted values of the equivalent conductance for tetra-*n*-butylammonium picrate in nitrobenzene (D.C. = 35). As may be seen from the figure, the points at lower concentration approximate a straight line whose slope is predetermined by the physical constants of nitrobenzene. Obviously, in the case of this solvent, solutions of tetrabutylammonium picrate follow the same laws as do solutions of ordinary salts in water.

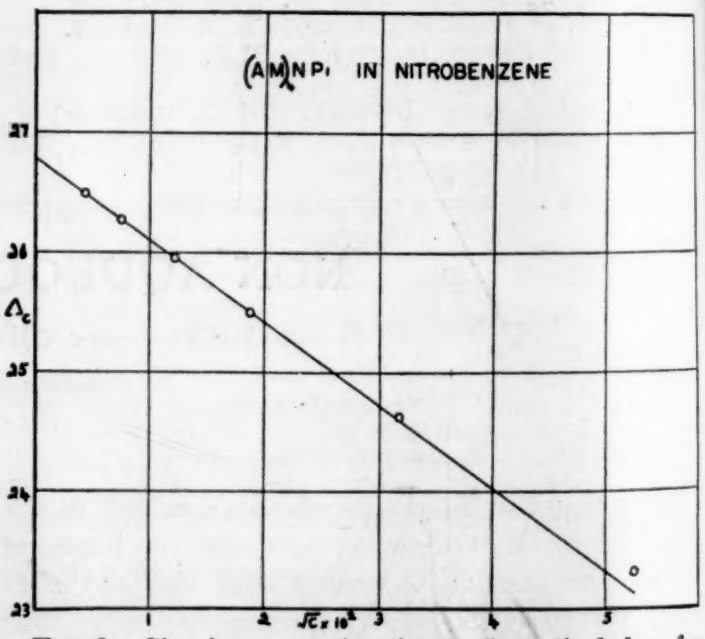

FIG. 2. Showing approximation to theoretical slope for tetra*iso*amylammonium picrate in nitrobenzene.

Ion Association. While the assumption of complete

dissociation of electrolytes in conjunction with the ion atmosphere theory of Debye and Hückel and Onsager gives an excellent account of the properties of electrolytic solutions at lower concentrations in solvents of high dielectric constant, it fails to account for the properties of electrolytic solutions in solvents of lower dielectric constant. This is well illustrated in Fig. 3,

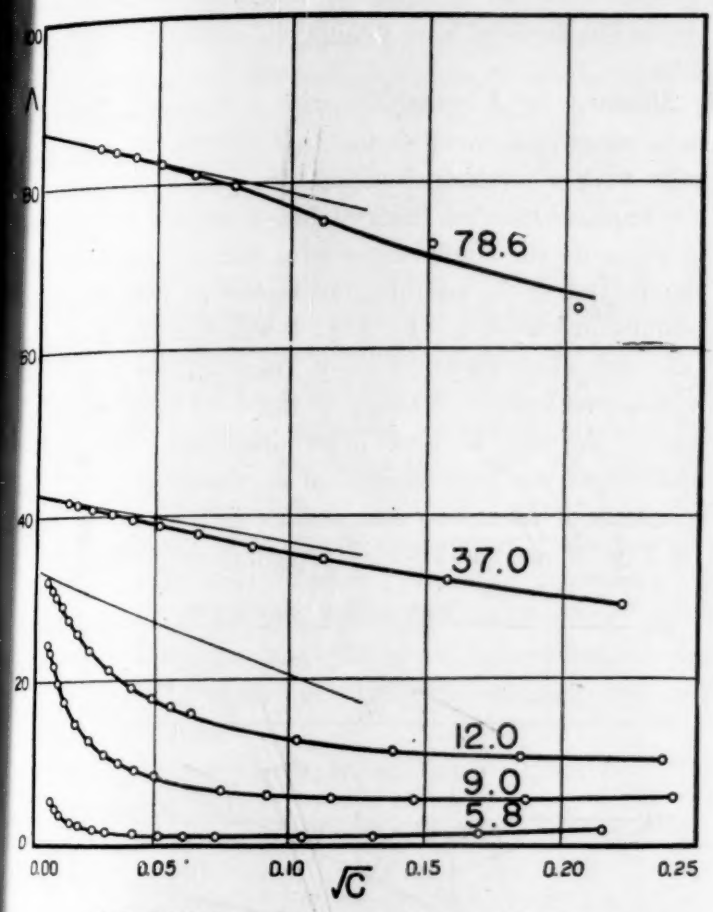

FIG. 3. Illustrating deviations from theoretical slope in solvents of lower dielectric constant.

where values of Λ are plotted against values of the square root of total salt concentration for solutions of tetra*iso*amylammonium nitrate in dioxane-water mixtures whose dielectric constants range from 78.6 to 5.8. The values of the dielectric constant are shown on the figure. As may be seen from the figure, in the two uppermost curves for solvents having dielectric constants of 78.6 and 37.0, respectively, the conductance curves approach the theoretical slope tangentially in accord with the theory. For the solvent mixture having a dielectric constant of 17, the conductance curve fails to approach a limiting tangent. In solvents of still lower dielectric constant, the aberration from the simple ion-atmosphere theory is even more marked.

It is evident that in solvents of lower dielectric constant, a new phenomenon intervenes as a result of which the conductance diminishes much more rapidly with concentration than is called for by the ion atmosphere theory. What happens is that, in solvents of low dielectric constants, the energy of a pair of ions in contact becomes sufficiently great to render such a pair of ions measurably stable; in other words, complete dissociation of the electrolyte no longer occurs at measurable concentrations. It is, therefore, necessary to take into account an equilibrium between associated ions (ion pairs) and free ions in accordance with the equation:

$$M^+X^- \rightleftharpoons M^+ + X^-. \qquad (A)$$

This equilibrium is subject to the law of mass action, but, since the ions exist in the presence of other ions, their long-range interactions must be taken into account in accordance with the theory of Debye and Hückel and Onsager.

Assuming the associated ions, or ion pairs, to be normal in their thermodynamic behavior, while the free ions conform to the ion atmosphere theory, relations are readily obtained by means of which conductance data may be conveniently treated. In general, suitable functions are plotted such that if the assumed relations are correct, they lead to a linear plot. From the plots may be derived the value of the limiting conductance, Λ_o, and the dissociation constant, K, of the mass action equilibrium (A).

In Fig. 4 are shown such plots for solutions of

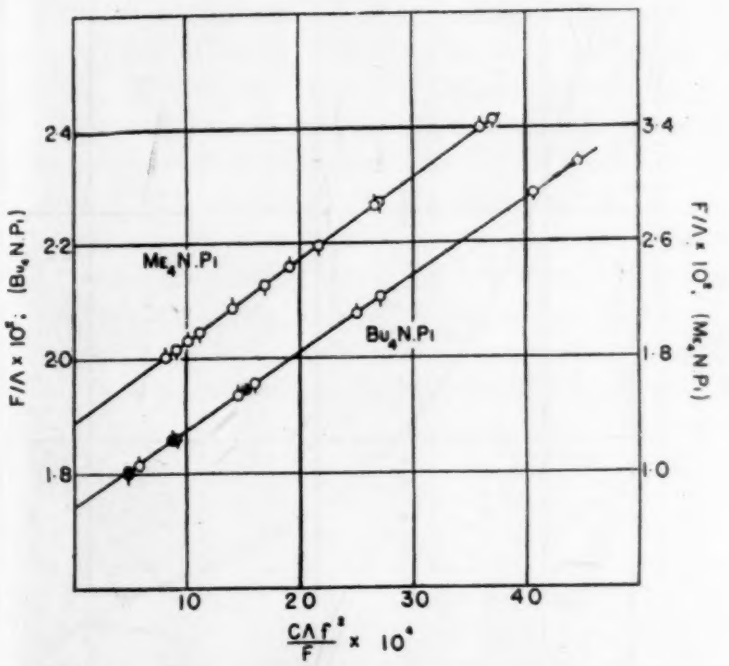

FIG. 4. Illustrating agreement of experimental and theoretical values for solutions in ethylene chloride.

tetramethyl- and tetra-*n*-butylammonium picrates in ethylene chloride (D.C. 10.3). As may be seen from the figure, the points, for both electrolytes, lie upon a straight line well within the limit of experimental error, which is less than 0.1 per cent. In the case of tetrabutylammonium picrate, concentrations have been carried as low as 1×10^{-5} N.

Bjerrum's Theory of Ion Association. Some years ago, Bjerrum developed a theory of ion association.

Without going into details, it may be stated that he derived a relation connecting the association constant (reciprocal of dissociation constant) with the temperature, the dielectric constant of the medium and the sum of the ionic radii. The association constant stands in reciprocal relation to the product of these parameters, so that the dissociation constant is the greater, the larger the dielectric constant of the solution and the larger the radii of the ions. From the conductance data for solutions of tetra*iso*amylammonium nitrate in mixtures of dioxane and water, values of dissociation constants have been obtained by the method indicated above. Knowing the dissociation constants of the electrolyte for the different mixtures and the value of the dielectric constant for these mixtures, it becomes possible to make a test of Bjerrum's theory. While the ion diameters of the electrolytes of these solutions are not known, ion diameters may be assumed of such value as to pass the theoretical curve through one of the experimentally determined K-values. If the theory is correct, the curve should then pass through the remainder of the experimental K-values within the limit of experimental error. In Fig. 5 is shown a plot of

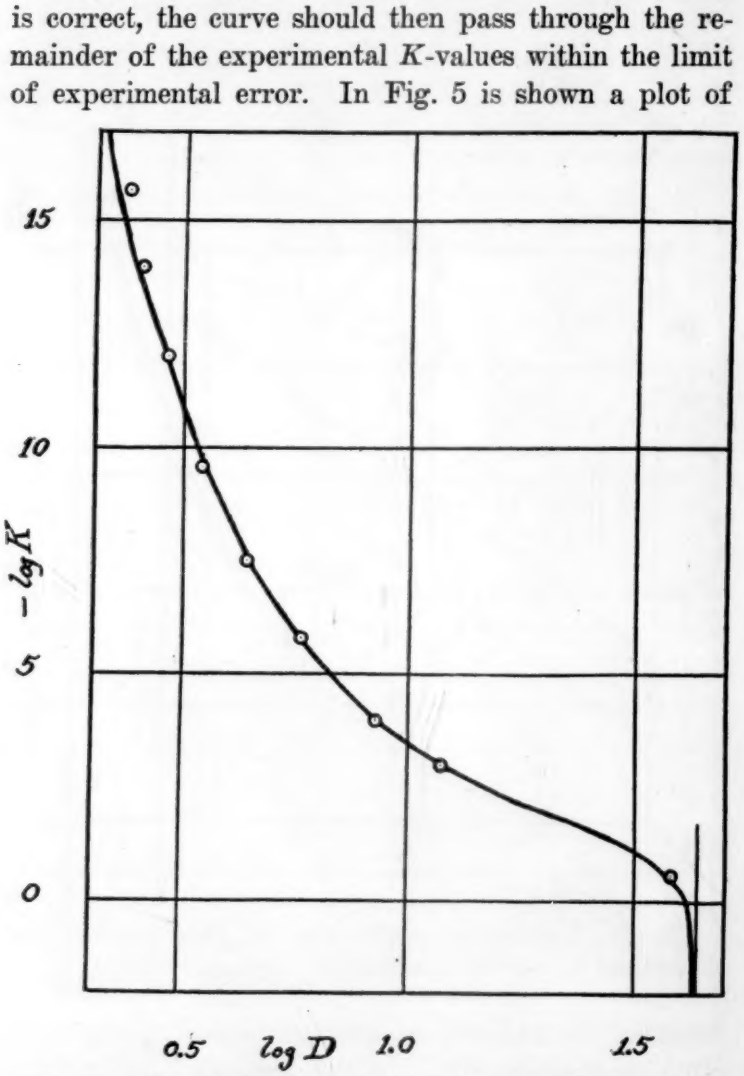

FIG. 5. Experimental and theoretical values of dissociation constants compared.

the negative logarithm of the dissociation constant (-log K) against the logarithm of the dielectric constant of the solvent medium (log D). The continuous curve is based on a value of 6.4 Å for the sum of the ionic radii. Inspection of the plot will show that the theoretical curve passes through all experimental values well within the limit of experimental error. The plot also shows that at a certain value of the dielectric constant, the curve turns sharply downward and crosses the axis of log D. For mixtures having dielectric constants in this region, the dissociation constant of the electrolyte is very large, which means that for these mixtures and other mixtures of higher dielectric constant, the electrolyte is completely dissociated into its ions.

Mixtures of Electrolytes with a Common Ion. If, in a solvent of lower dielectric constant, we have two salts with a common ion, each of which conforms to the requirements of theory, then it should be possible to compute the conductance of a mixture of these two electrolytes if the conductance curves of the pure compounds are known. In Fig. 4 were shown plots for two such electrolytes, namely, tetramethyl- and tetra-*n*-butylammonium picrates, in ethylene chloride. Values of Λ_0 and K were determined from these plots and therefrom were computed conductance values for mixtures of these two components in the same solvent. In Fig. 6 are shown the experimentally determined

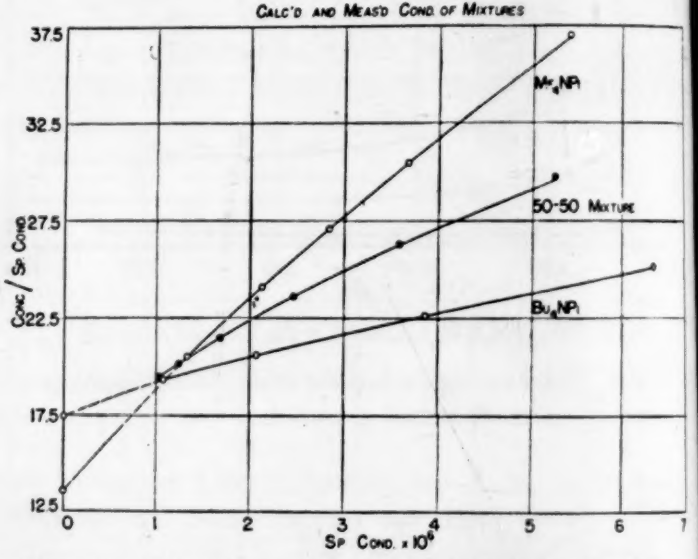

FIG. 6. Showing agreement of experimental and computed conductances for mixtures of electrolytes.

values (open circles) for the pure components. The continuous curves passing through these points are the theoretical curves. Between these curves is shown the computed curve for a 50-50 mixture of the two electrolytes; the experimental values are indicated by black circles. The experimental and computed values are in agreement within the error limit of 0.1 per cent.

Triple Ion Equilibrium. As shown in the first figure, for solutions of tetra*iso*amylammonium nitrate in mixtures of dioxane and water, all conductance curves in mixtures of lower dielectric constant exhibit a minimum. This phenomenon is a very general one and can only mean that in the region where the conductance increases with increasing concentration, the relative number of ions which carry the current is

likewise increasing. This may be accounted for by assuming a further interaction due to Coulomb forces, namely, an interaction between the ion pairs and simple ions. The ion pairs are electrical dipoles and have a measurable electric moment. If, therefore, an ion comes into the neighborhood of an ion pair, a force acts between them which varies inversely as the cube of the distance. In solvents of lower dielectric constant, the energy due to this interaction becomes sufficiently great to render systems of this type stable. We thus have equilibria in accordance with the equations:

$$M^+X^- + M^+ = M^+X^-M^+$$
$$M^+X^- + X^- = X^-M^+X^- \qquad \text{(B)}$$

The complex ions, called triple ions, $M^+X^-M^+$ and $X^-M^+X^-$, carry, each, one unit of charge. As a result of the existence of these equilibria (B), the number of ions in solution at a given concentration will be greater than it would be if only the simple equilibrium (A) were involved. In solutions of a weakly dissociated electrolyte, the fraction of electrolyte present as triple ions increases with increasing concentration and a point is ultimately reached where the increase in the number of triple ions exceeds the decrease in the number of simple ions. It is evident, therefore, that, as a result of these equilibria, the conductance curve will exhibit a minimum.

In Fig. 7 are shown conductance curves for tetra-

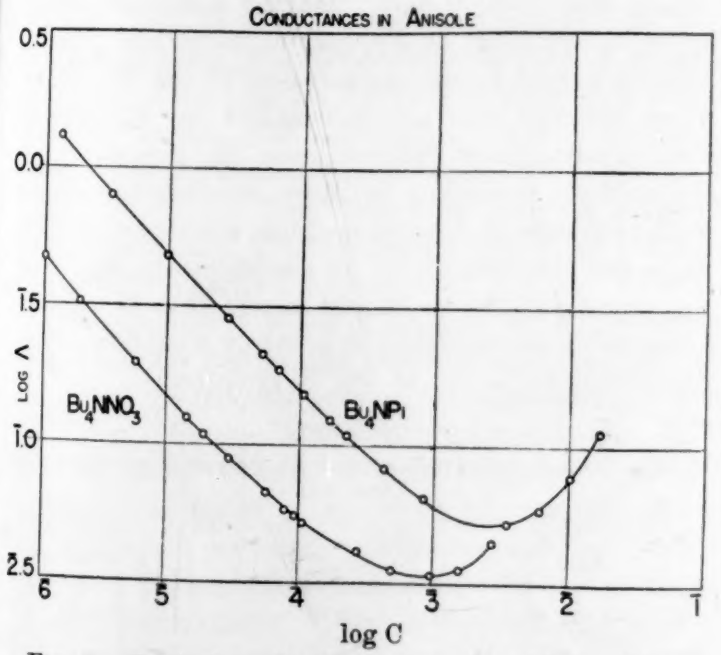

FIG. 7. Typical conductance curves in solvents of lower dielectric constant.

butylammonium thiocyanate and tetrabutylammonium nitrate in anisole (D.C. 4.29). The form of these curves is characteristic of solutions of binary electrolytes in solvents of lower dielectric constant. The slope of the curves at lower concentrations is characteristic of the equilibrium between simple ions and ion pairs for a weakly dissociated electrolyte.

Taking into account the equilibria (A) and (B), together with the ion atmosphere effect for the free ions, simple as well as triple, functions may be plotted, such that if the theory is applicable, the experimental points will lie upon a straight line. Such a plot is shown in Fig. 8 for solutions of tetrabutylammonium

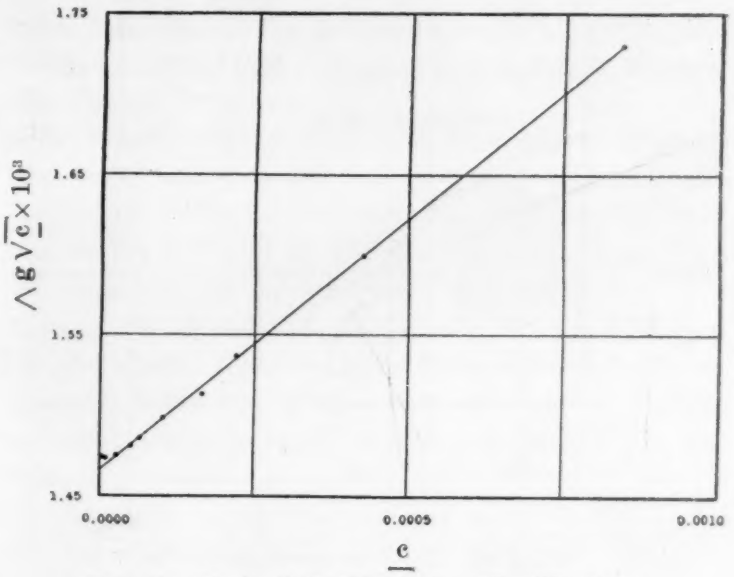

FIG. 8. Test of the Triple Ion Equilibrium.

picrate in anisole. As may be seen from the plot, the points approximate a straight line within the limits of experimental error. There seems little doubt that in solvents of lower dielectric constant, interaction between the ion pairs and free ions comes into play.

Concentrated Solutions. In solvents of very low dielectric constant, interactions of still higher type occur. This is illustrated, for example, by the complexity of the conductance curves at higher concentrations. Depending upon the nature of the electrolyte, the conductance curves may or may not exhibit several inflection points in the concentrated region. In Fig. 9 are shown plots of the logarithms of equiva-

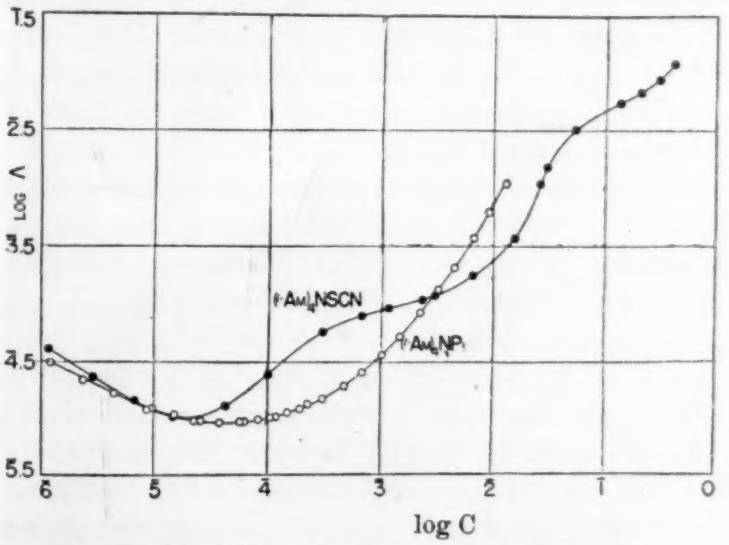

FIG. 9. Typical conductance curves in benzene.

lent conductance and of concentration for solutions of tetra*iso*amylammonium picrate and thiocyanate in ben-

zene solution. As may be seen from the figure, the curve for the picrate is everywhere concave upward, while that for the thiocyanate exhibits several inflection points. The latter type of curve is the more common.

A study of the molecular weight of electrolytes in benzene solution gives further evidence indicating the complexity of the interactions in concentrated solutions of electrolytes in benzene. In Fig. 10 are shown

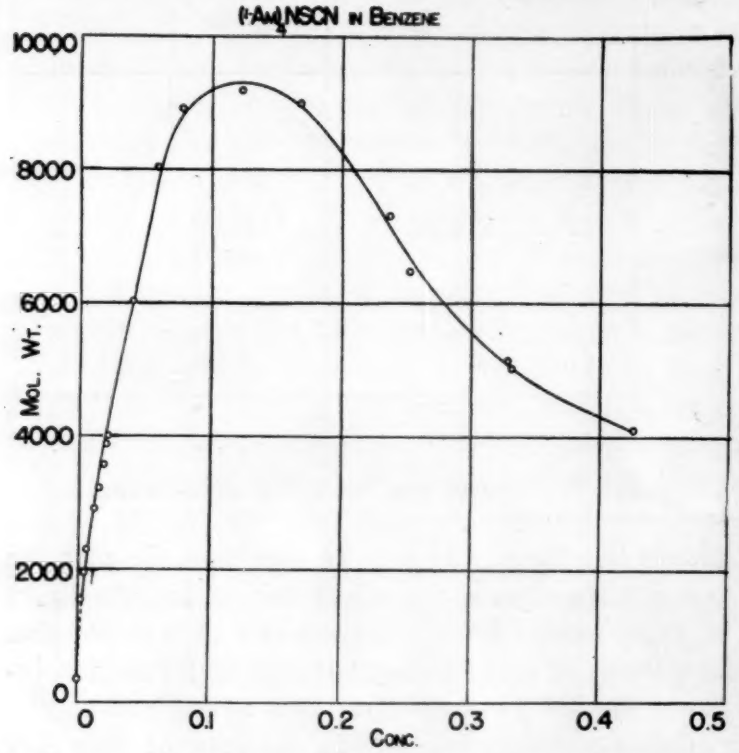

FIG. 10. Molecular weight of tetra*iso*amylammonium thiocyanate in benzene.

values of the apparent molecular weight as a function of concentration for solutions of tetra*iso*amylammonium thiocyanate in benzene. The formula weight of this electrolyte is 356.4; at approximately 1×10^{-3} N, the molecular weight is 1,500, and thereafter it increases with increasing concentration until it reaches a maximum of 9,200 at a concentration of 0.12 N. Thereafter, the molecular weight diminishes with increasing concentration, reaching a value of 4,100 at a concentration of 0.425 N.

Ion Dipoles. From conductance measurements, there is obtained evidence of the existence of ions, but information relating to uncharged molecular species depends upon inference. If ions associate to form ion pairs, such ion pairs must have relatively high polar moments. If, therefore, an electrolyte is dissolved in a non-polar medium, the dielectric constant of the solution should be markedly greater than that of the pure solvent. Experiment has shown that this is actually the case. From dielectric constant measurements with solutions of electrolytes in benzene, molecular polarization values have been computed; these values are shown in Fig. 11. As may be seen, these polarization values are high, ranging all the way from

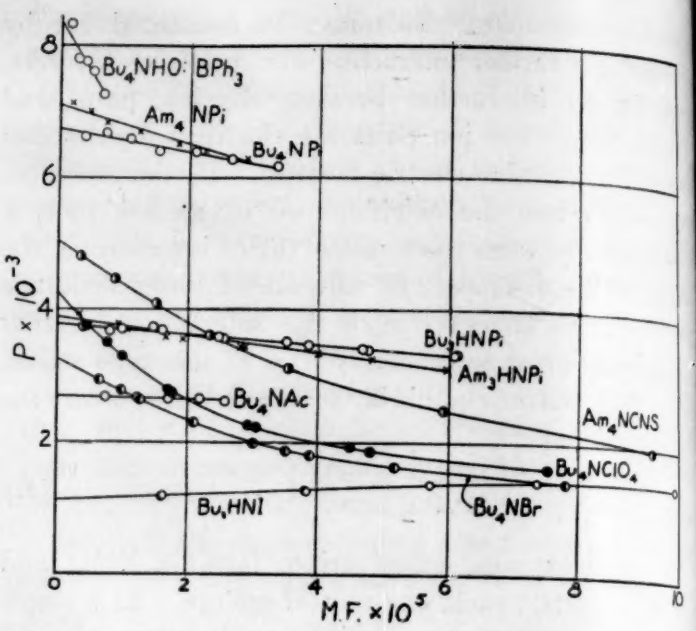

FIG. 11. Polarization curves of electrolytes in benzene solution.

1,500 to 8,000 cubic centimeters. The polar moments range from 8 to 20 Debye units. Ordinary, highly polar molecules, such as nitrobenzene, have molecular polarization values in the neighborhood of 500 cubic centimeters. The properties of dilute solutions of electrolytes in benzene, therefore, give direct evidence of the existence of ion pairs.

III. Influence of Constitutional Factors

Size and Configuration. Having discussed the behavior of solutions of electrolytes in various solvents without regard to the constitution of the ions themselves, we may now briefly consider the influence of such constitutional factors upon the properties of electrolytes. According to theory, an electrolyte should be the stronger in a given medium, the larger its ions. Since the conductance of an electrolyte is the lower, the larger its ions, we should expect that as the conductance of an electrolyte is lower, in a given medium, its dissociation constant will be greater.

TABLE I

Ion Conductances and K-values of Picrates in Ethylene Chloride

Ion	Λ_o^+	$K \times 10^4$
Me_4N^+	42.6	0.326
Et_4N^+	38.2	1.59
n-Pr_4N^+	31.5	1.90
n-Bu_4N^+	26.2	2.18
n-Am_4N^+	23.3	2.38

In the second column of Table I are given conductance values of tetramethyl-, tetraethyl-, tetra-*n*-propyl-, tetra-*n*-butyl- and tetra-*n*-amylammonium ions, in ethylene chloride at 25°. In the third column are given values of the dissociation constant of picrates of the same ions.

In Fig. 12, these values of the ion conductances and

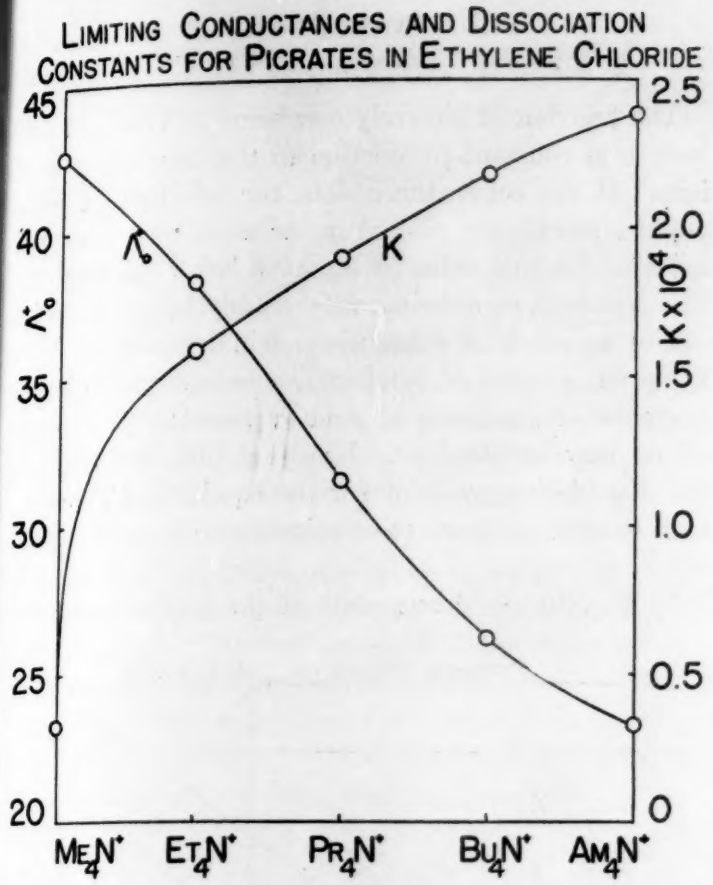

FIG. 12. Illustrating dependence of dissociation constant on ion size.

dissociation constants are shown graphically as functions of the number of carbon atoms in the substituent alkyl groups. It may be seen from the figure, as from the table, that as an ion is more complex and its conductance is lower, the dissociation constant of its salt is greater. The greatest increase of dissociation constant per carbon atom takes place between the tetramethyl- and the tetraethylammonium salts. This regularity, which has been found to hold in ethylene chloride solutions, likewise holds in all other solvents that have thus far been investigated.

If we consider a series of salts of various negative ions, we again find similar relationships, namely, that the larger the ion, the greater the dissociation of the electrolyte. In the case of unsymmetrical ions, that is, ions where the central negative charge is asymmetrically located with respect to the structure of the ion as a whole, we must take into account, not merely the size of the ion, but also its configuration. In Table II are given values of Λ_0 and K for sodium salts of a number of negative ions in liquid ammonia at its boiling point.

TABLE II

CONSTANTS OF SODIUM SALTS IN LIQUID AMMONIA

Salt	Λ_0	$K \times 10^4$
$NaOC_6H_5$	279.4	3.82
$Na\beta\text{-}OC_{10}H_7$	268.1	6.50
$Na\alpha\text{-}OC_{10}H_7$	265.3	8.08
$NaSC_2H_5$	281.4	22.5
$NaSC_6H_5$	275.1	36.0
$NaSn(C_6H_5)_3$	220.	150.

It will be noted that sodium β-naphtholate is a markedly stronger electrolyte than sodium phenolate. The larger dissociation constant of the naphtholate is due to the greater size of the naphthyl group. With the phenolic oxygen atom in the α in place of the β position, the strength of the electrolyte is further increased by about 30 per cent. It is not alone the size of the group attached to the oxygen atom that must be considered but also the relation of the oxygen atom to other atoms in the ion.

It is interesting to compare the dissociation constant of sodium phenolate with that of sodium thiophenolate. In the case of the thiophenolate ion, the charge is localized on the sulfur atom, which is markedly larger than the oxygen atom. As a result, the dissociation constant of the thiophenolate is nearly ten times that of the phenolate. Even sodium ethylsulfide is a markedly stronger electrolyte than sodium phenolate. In this connection, it may be stated that the dissociation constant of potassium chloride is 8.73×10^{-4}. By localizing the charge of the negative ion on still larger atoms and by associating large groups with such atoms, it is possible to build up electrolytes that are even stronger than those already considered. Sodium triphenylstannide $NaSn(C_6H_5)_3$ has a dissociation constant of approximately 150×10^{-4} in liquid ammonia; in other words, it is nearly twenty times as strong an electrolyte as potassium chloride.

Choline Salts. It is of interest to determine what influence elements other than carbon and hydrogen may have on the strength of electrolytes when introduced into the positive ion. For example, a hydroxyethyl group may be introduced into a quaternary ammonium ion in place of an ethyl group. The hydroxy group of a compound of this type may be replaced by halogens and other suitable groups and, in place of an ethyl group, methyl or other organic groups may be employed. In Table III are given values of the dissociation constant for a series of electrolytes of this type, dissolved in ethylene chloride.

TABLE III

CHOLINE SALTS IN ETHYLENE CHLORIDE AND NITROBENZENE

Salt	$K \times 10^4$	
	$C_2H_4Cl_2$	$C_6H_5NO_2$
$Et \cdot Me_3NPi$	0.460	575.0
$HOC_2H_4 \cdot Me_3NPi$	0.0659	67.0
$CH_3OCH_2 \cdot Me_3NPi$	0.254	262.0
$BrC_2H_4 \cdot Me_3NPi$	0.132	....
$BrCH_2 \cdot Me_3NPi$	0.078	....

It will be noted that hydroxyethyltrimethylammonium picrate (choline picrate) has a dissociation constant about one seventh that of ethyltrimethylammonium picrate. Throughout the series of salts appearing in the table, the dissociation constants are markedly lower than those of corresponding salts in which only hydrocarbon groups are present in the positive ions.

Partially Substituted Ammonium Salts. If, in place of the quaternary ammonium salts, partially substituted ammonium salts are employed in ethylene chloride or nitrobenzene, it is found that these substances uniformly behave as weak electrolytes. In general, their dissociation constants are approximately 1,000 times smaller than those of the corresponding completely substituted salts. In Table IV are given values of the limiting conductances and the dissociation constants of a series of butylammonium picrates dissolved in nitrobenzene at 25°.

TABLE IV

CONSTANTS OF PARTIALLY SUBSTITUTED AMMONIUM SALTS IN $C_6H_5NO_2$

Salt	Λ_o	$K \times 10^4$
NH_4Pi	34.3	1.46
$BuNH_2Pi$	32.79	1.50
Bu_2NH_2Pi	30.36	1.51
Bu_3NHPi	28.86	1.90
$BuNH_3ClO_4$	37.75	25.2
Bu_2NHI	33.48	0.943
$C_5H_{10}NH_2Pi$	33.27	1.55

On examining the table, it will be noted that ammonium picrate and monobutyl- and dibutylammonium picrates have dissociation constants of approximately 1.5×10^{-4}; tributylammonium picrate has a slightly higher constant, 1.9×10^{-4}. Tetrabutylammonium picrate is a very strong electrolyte with a constant greater than 2000×10^{-4}. The strength of a partially substituted ammonium salt depends but little upon the nature of the positive ion. Thus, the constant for pyridonium picrate is 0.53×10^{-4}, that of piperidonium picrate is 1.55×10^{-4} and that of ammonium picrate is 1.46×10^{-4}. The negative ion, however, has a marked influence on the dissociation constant. For butylammonium picrate, the constant is 1.50×10^{-4}, while for butylammonium perchlorate it is 25.2×10^{-4}.

The presence of hydrogen attached to nitrogen in the positive ion appears to introduce an energy term as a result of which the dissociation constant of the electrolyte is smaller than that of an electrolyte in which Coulomb forces alone are involved. Seemingly, there is an interaction between the proton attached to nitrogen and the negative ion. This view is supported by the fact that the partially substituted ammonium salts, including ammonium salts, are normally strong electrolytes in pyridine. Interaction between the proton and the negative ion is also indicated by the dependence of the dissociation constant upon the nature of the negative ion as exemplified by the picrate and the perchlorate in Table IV.

Acid-Base Dissociation. In the case of salts of weak bases, dissolved in non-basic solvents like nitrobenzene and ethylene chloride, an acid-base dissociation occurs. For example, in solutions of pyridonium picrate, we have to consider the two equilibria:

$$C_5H_5NH^+Pi^- \rightleftharpoons C_5H_5NH^+ + Pi^- \quad (C_1)$$
$$C_5H_5NH^+Pi^- \rightleftharpoons C_5H_5N + HPi \quad (C_2)$$

The fraction of electrolyte existing as free acid and base is in constant proportion to that existing as free ions. If the conductance data for solutions of pyridonium picrate are plotted in the usual way, the curve extrapolates to a value of Λ_o much below the true one. The acid-base equilibrium may readily be repressed by adding an excess of either picric acid or pyridine. Carrying out a series of conductance measurements in the presence of an excess of acid or base, the true value of Λ_o may be obtained. Knowing this, the value of the dissociation constant for the equilibria C_1 and C_2 may be obtained from the conductance data of the pure salt.

In Fig. 13 are shown plots of the conductance data

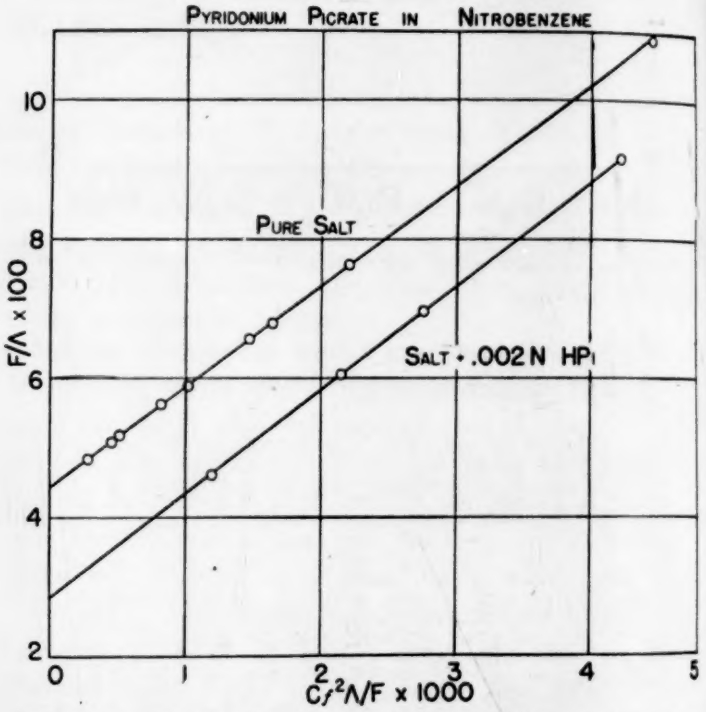

FIG. 13. Illustrating repression of ion-base dissociation in nitrobenzene.

for solutions of pyridonium picrate in pure nitrobenzene and in nitrobenzene containing 0.00203 N picric acid. The ordinates are proportional to $1/\Lambda$ and the intercepts on the axis of ordinates are the values of $1/\Lambda_o$. As may be seen from the figure, the value of Λ_o obtained for pyridonium picrate in pure nitrobenzene (upper curve) is 22.52, while that in the presence of picric acid is 35.1. A series of measurements carried out with the addition of picric acid and of pyridine to solutions of pyridonium picrate yields 35.0 as the most probable value of Λ_o and 0.551×10^{-4} as the most probable value of the dissociation constant for the pure electrolyte. These yield a value of 1.74×10^{-5} for the dissociation constant of the acid-base equilibrium C_2. In Table V are given values of Λ_o and of the dissociation constant for pyridonium picrate in the presence of varying amounts of picric acid and of pyridine.

TABLE V

CONSTANTS OF PYRIDONIUM PICRATE IN THE PRESENCE OF VARYING AMOUNTS OF PICRIC ACID AND PYRIDINE

Conc. HPi	Λ_o	$K \times 10^4$	Conc. Pyridine	Λ_o	$K \times 10^4$
0.0	35.0	0.551	0.00095	34.76	0.580
.00077	35.6	.524	.0101	34.19	0.876
.00203	35.1	.545	.0272	34.00	1.34
.00420	35.8	.524	.0528	33.80	2.21

The Λ_o values obtained on addition of the acid are subject to experimental errors of the order of one-half unit, due, in part, to the conductance of picric acid itself. It is safe to conclude, however, that both Λ_o and K are independent of the amount of picric acid added in the concentration range of the table. In the presence of pyridine, the values of both Λ_o and K are functions of the concentration of excess pyridine. There is a rather marked decrease in the value of Λ_o with increasing concentration of pyridine, which seems to be a real effect and is not due to change in the viscosity of the solutions. The dissociation constant, upon addition of pyridine, increases markedly. This constant is very nearly a linear function of concentration of pyridine and extrapolates to a value of 0.551×10^{-4} for the dissociation constant of pyridonium picrate in pure nitrobenzene. This value of the constant harmonizes with the value of 35.0 for Λ_o.

Proton Interaction. The influence of bases upon the dissociation constant of electrolytes that have an active proton in the positive ion is quite a general phenomenon. In the case of the partially substituted ammonium salts, the investigation of the phenomenon is limited to a base identical with that of the salt. It is possible to investigate the phenomenon more advantageously, however, with salts of the quaternary type in which an OH group is attached to the nitrogen of the ammonium ion. In solvents such as ethylene chloride and nitrobenzene, these hydroxyammonium salts are even weaker electrolytes than are the partially substituted ammonium salts. In Table VI are given values of the dissociation constant of hydroxytrimethylammonium picrate in pure nitrobenzene and in nitrobenzene to which have been added varying amounts of different bases.

TABLE VI

INFLUENCE OF BASES ON THE CONSTANT OF HYDROXYTRIMETHYLAMMONIUM PICRATE IN NITROBENZENE

Base	$K \times 10^4$	Base (C_5H_5N)	$K \times 10^4$
0	0.169	0.00104	0.353
$C_5H_{11}N$ 0.010	11.0	.0101	1.19
$(C_2H_5)_3N$ 0.038	10.0	.037	3.33

As may be seen from the table, the salt has a dissociation constant of 0.169×10^{-4}. With addition of pyridine, the dissociation constant increases, reaching a value of 3.33×10^{-4} for a pyridine concentration of 0.037 N. The stronger the base, the greater is the increase of the dissociation constant at a given concentration of base. Thus, in a 0.01 N solution of pyridine, the dissociation constant is 1.19×10^{-4}, while in a 0.01 N solution of piperidine, the dissociation constant is 11×10^{-4}. In other words, while a 0.01 N solution of pyridine increases the dissociation constant of the electrolyte approximately seven times, a 0.01 N solution of piperidine increases it nearly seventy times. Triethylamine is intermediate in its effect on the dissociation constant; at a concentration of 0.038 N, the constant is approximately three times that of a pyridine solution of the same concentration.

The influence of bases upon the dissociation constant of salts of the type here under discussion is largely, if not wholly, due to interaction of the base with the proton of the hydroxy group of the positive ion. When these electrolytes are dissolved in basic solvents they are normally strong electrolytes. For example, the dissociation constant of phenylhydroxydimethylammonium picrate in nitrobenzene (D.C. = 35) is 0.18×10^{-4}, while dissolved in pyridine (D.C. = 12.03), its dissociation constant is 12.5×10^{-4}.

IV. CONCLUSION

The properties of solutions of typical strong electrolytes are little influenced by the chemical nature of the medium in which they are dissolved; they are chiefly, and very generally, determined by the dielectric constant of the solvent. In a solvent of high dielectric constant, electrolytes are completely dissociated into their ions. In solvents of somewhat lower dielectric constant, short-range ion interaction occurs and an equilibrium exists between simple ions and ion pairs; in solvents of still lower dielectric constant, ions and ion pairs associate to form triple ions. In solvents of very low dielectric constant, association becomes extremely complex at higher concentrations, leading to very complex relations between the concentration and the various physical properties of the solutions.

The association of ions to ion pairs depends, in the first place, upon the size of the ions. It also depends upon the geometrical structure of the ions and the distribution of charge among the various atoms of this structure.

Where interactions other than Coulombic occur between the ions or where special interactions occur between the ions and the solvent molecules, the properties of solutions depend upon the nature of the solvent medium. Certain acids, for example, are strong electrolytes in water but are very weak or non-electrolytes in nitrobenzene. In the case of nearly all the weak electrolytes, interactions other than Coulombic are present and the properties of their solutions are dependent upon the nature of the solvent medium as well as upon its dielectric constant.

OBITUARY

FREDERICK PARKER GAY

WHENEVER one of the really great men of science passes from our midst, not only are our hearts filled with sorrow for the loss of a dear and esteemed colleague, but our minds pause long enough to reflect upon a personality which has exercised such a tremendous influence on the time and sphere in which he lived and worked. These were the emotions and thoughts that came to the scientific world with the news of the death of Frederick Parker Gay on July 14, 1939.

Born in Boston, Mass., on July 22, 1874, he received a classical preparatory education at Boston Latin School and Harvard University. His career in research began early while he was still a medical student at the Johns Hopkins University. As assistant to Dr. Simon Flexner he traveled around the world with the Johns Hopkins Medical Commission, stopping in the Philippines to investigate cholera and dysentery. About thirty years later he was to return to the same Islands, this time in quest of leprosy, as a member of the Leonard Wood Memorial Commission.

By 1901, when Dr. Gay was graduated from medical school, the science of bacteriology was blossoming prodigiously and its spectacular achievements could not help but attract a man with Gay's intellectual curiosity and emotional drive. Because medical bacteriology began as a branch of morbid anatomy, the young bacteriologist naturally entrusted his early instruction to the pathologist. An award of the first fellowship by the new-born Rockefeller Institute opened a position as assistant demonstrator in pathology at the University of Pennsylvania from 1901–1903. For some years later Gay continued to call himself a pathologist; but as he advanced in age there developed in him a growing interest in the fundamental problems of microbiology which was to carry his activities far beyond the conventional lines of medical bacteriology. An inborn desire to elucidate principles rather than to record phenomena was probably the reason for his early association with the great theoretical genius of his time, Jules Bordet in Brussels. Here, during the years 1903 to 1906, his attention was fully absorbed by an investigation of the complexities of the alexin fixation reaction which was to initiate a long and fruitful series of contributions in the field of immunology. An important by-product of this period was his first book, a translation into English of the "Studies in Immunity" by Bordet and his collaborators, published in 1909. When he returned to this country, his scientific progress was one of uninterrupted activity and his career one of increasing momentum. During the years 1906 and 1907 he served as bacteriologist to the Danvers Insane Hospital in Massachusetts; between 1907 and 1909 he was assistant and later instructor in pathology at the Harvard Medical School. In 1910 he became professor of pathology at the University of California at Berkeley. Here he remained for thirteen years, except for a brief period of service as major in the Medical Corps of the U. S. Army during the World War. It was towards the end of his stay in California that he succeeded in developing bacteriology and immunology as independent sciences, separate from pathology, a division which led to his appointment, in 1921, as professor of bacteriology and director of the newly organized department. In 1923 he went to Columbia University as head of the department of bacteriology, a position which he occupied until his death.

His many contributions to bacteriology and immunology are known to all workers in the field and need no extensive review here. In roughly chronological order they included: studies of the serum reactions, particularly conglutination and alexin fixation (1905–10); anaphylaxis (1905–13); typhoid fever, both experimental studies of the carrier state in animals and immunization, vaccine therapy and skin tests in man (1913–18); pathogenesis and chemotherapy of hemolytic streptococcus infections (1919–39); tissue immunity, in particular the rôle of tissue macrophages (clasmatocytes) in enhancing local resistance and the relation of the reticulo-endothelial system to the formation of antibodies (1920–31); virus infections, especially the problem of the interrelationship of herpes and encephalitis (1929–39). He was also author of a number of papers on general topics in the realm of medical education and the historical development of bacteriology. Besides the translation of Bordet's "Studies in Immunity" he also wrote a monograph on "Typhoid Fever" (1918). In 1935 there appeared "Agents of Disease and Host Resistance," the most extensive American system of bacteriology, immunology and related aspects of the etiology of disease, which he planned and edited and of which he contributed the major part. His last book, "The Open Mind" (1937), was a monument to E. E. Southard, with whom he shared the bonds of a deep friendship as well as an intense interest in problems of psychiatry and sociology.

It may be taken for granted that a man who held such a key position in research and medical education should have shared generously in the honors and distinctions that science bestows on its outstanding exponents. Through his early affiliation with Bordet he belonged to the Société belge de Biologie. All prominent scientific societies in America counted him among their members, and often their president. From 1917 to 1918 he was a member of the Medical Section of the National Research Council, functioning

first as its chairman and later as chairman of its Medical Fellowship Board. With the foundation of the American Commission for Relief in Belgium he was appointed exchange professor from Columbia University to Belgian Universities (1926–27); from 1932 to 1936 he served as chairman of the Advisory Committee on Research of the Leonard Wood Memorial. He was a Commander of the Order of the Crown of Belgium and received an honorary Sc.D. degree from George Washington University in 1932. At a meeting of the National Academy of Sciences in Washington, D. C., held in April, 1939, Dr. Gay was made a member of this society.

It would be difficult to say whether Gay's contributions to science, brilliant as they were, or the unforgettable part he played as an inspiring teacher and counselor were foremost in helping him to win the unique distinction that was his. A man of rare culture and outspoken personality, he would naturally imbue his lectures with an air of scholarly refinement that could not fail to make a deep impression on young medical students. But his presentation had also an unusual eloquence, an originality and facility of expression which made it an esthetic pleasure to listen to him. He was truly master of the printed and the spoken word. For there was in Gay's make-up a strong artistic impulse that often helped him to bridge the gap between intellectual skepticism and intuitive vision. This artistic talent, which found its natural outlet in literature and poetry, undoubtedly was a great creative force in Gay's productivity. At the peak of his life, it led him once to formally pose the question whether one good sonnet might, perhaps, not be worth more than a sheaf of scientific papers. A man with such gifts of mind and soul could not help but attract a wide circle of devoted friends and associates. This affectionate regard, which all who knew him intimately learned to share for Dr. Gay, was sometimes difficult to fathom for others whose contact with him was only brief. At first sight he often seemed cool and aloof, perhaps even introverted. His nature had in it a certain shyness, characteristic of all great men, which did not permit him the easy approach in establishing human relations. Coupled with this was an utter sincerity and fearless insistence on the rightness of certain principles—to which he sometimes referred as his New England conscience—which may occasionally have colored his decisions with an arbitrary note. Mistaken superficial impressions of this kind, however, can not do justice to the warm-hearted character that was capable of forging such strong bonds of affection with those who were close to him.

Had he lived but a little longer, there might have been a greater measure of outward perfection in his life even though his work was done, by his own decision. Earlier in the year he had made known to his associates his intention to retire from active service after a contemplated year's leave of absence. He had looked forward to a few quiet years at his beautiful country home, in pursuit of hobbies and in happy enjoyment of family life. Fate decided differently for him. He had not been seriously ill, except for recurring anginoid attacks during the last year or two. He passed away in his sleep, quietly, we hope painlessly. Death had gently shut the door upon a full life.

CLAUS W. JUNGEBLUT
COLLEGE OF PHYSICIANS AND SURGEONS,
COLUMBIA UNIVERSITY

WILLIAM R. PERKINS

PROFESSOR W. R. PERKINS, vice-director, emeritus, of the Mississippi State Experiment Station, died on August 21 after forty-eight years of notable activity in agricultural work in three states, Mississippi, South Carolina and Louisiana. After graduation from the State College of Mississippi in 1891, he was employed as chemist in the Experiment Station until 1893, when he became agronomist in the Station and professor of agronomy in the college for the following seventeen years. In 1910 he was called to Clemson College, South Carolina, where he remained two years. For the next three years he determined to put in practice the facts which he had found in chemistry and in agronomy and to try out the theories which he had formulated during the years of his teaching and experimenting. Thus he returned to Mississippi where he demonstrated in the practical operation of a farm the soundness of his factual knowledge and of some of his theories. But the educational authorities would not let him follow his natural desires, and in 1915 he was called to the Louisiana State University as forage crop specialist for the extension department. Later, he became director of the extension department, a position which he filled with marked success until in 1928, when he came back to his native state as assistant director of the South Mississippi Experiment Station at Poplarville. In 1930 he was made director of the state system of branch experiment stations and, finally, vice-director of the State Experiment Station at the State College.

Professor Perkins retired from his administrative duties at the age of 70, but continued his activities until illness prevented further work. He was engaged in gathering data and compiling a history of the Experiment Station with which he became officially connected six years after its establishment in 1885.

Professor Perkins was of a modest and retiring disposition, but his knowledge of the different phases of practical agriculture was broad and profound. He was widely known in the southern states for his work as an agricultural chemist, agronomist and administrator in extension and experiment stations. He early recognized the economic futility of a one-crop system, cot-

ton, and the distress to which it would finally lead southern agriculture. He saw the boundless possibilities in the growing of forage crops and the production of live stock under the most favorable climatic conditions in this country. In and out of season, he counseled conservation of the soil and diversification of agriculture.

He was much sought for his advice and counsel in all phases of agricultural work, for he was the kindliest of men, always ready to help to the full extent of his ability. He was a staunch and loyal friend to all who were earnestly striving to do their part in the world's work. The writer has known Mr. Perkins for more than forty years and during all that time we have known him to stand unflinchingly for the truth, even at times when it endangered his position to do so. If pressure to the contrary became too great he quietly stepped aside without recrimination, rather than to truckle to unwise dictators or to pernicious politics. Southern agriculture has lost a zealous advocate, an able administrator, a careful student and a just man.

GLENN W. HERRICK

RECENT DEATHS

SIGMUND FREUD died in London on September 23. He was eighty-three years old.

CHARLES F. SHAW, professor of soil technology at the University of California, died suddenly on September 12 at the age of fifty-eight years.

THOMAS D. RICE, senior soil scientist of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, died on August 23 at the age of sixty-one years.

L. W. FORMAN, superintendent of experiments in soils and research assistant professor in the Agricultural Experiment Station of the Iowa State College, died on September 9 at the age of fifty-eight years.

ANDREW CLAUDE DE LA C. CROMMELIN, for thirty-six years a member of the staff of the Royal Observatory, Greenwich, known for his work on comets and minor planets, died on September 20 at the age of seventy-four years.

SCIENTIFIC EVENTS

THE EVACUATION OF THE UNIVERSITY OF LONDON

IN its issue for September 12, the London *Times* reports that next term students of the University of London will be scattered over various parts of the United Kingdom. Arrangements were almost complete for the evacuation of the whole of the university, and it was hoped to begin the new term early in October. Meanwhile the administrative offices will remain at the Royal Holloway College, Englefield Green.

An attempt has been made, wherever possible, to move the whole of each college to its new home, and other universities have cooperated with London in completing its arrangements.

University College is the only one which had been unable to find accommodations for all its students in one place. The men are going to the University of Wales, Aberystwyth; the women medical students to Sheffield, and other women students to Wales.

King's College, which has decided to discontinue its courses in Spanish, journalism, psychology and chemical engineering and its evening classes, is going to Bristol.

Other colleges are going to the following places:

King's College of Household and Social Science, Wales.
Queen Mary College, Cambridge.
Institute of Education, University College, Nottingham.
School of Oriental Studies, Cambridge.
Goldsmiths' College, Nottingham.
Westfield College for Women, Oxford.
College of Pharmaceutical Society, Wales.
Bedford College. Not yet decided.
Imperial College of Science and Technology, Edinburgh.
The Mining Department is moving to Camborne, Cornwall.

The medical schools are going to the following centers:

St. Bartholomew's Hospital and College, London, and the London School of Hygiene and Tropical Medicine to Cambridge.
Guy's and St. Thomas's to Oxford.
Middlesex to Bristol.
St. Mary's to Manchester.
London School of Medicine for Women to Aberdeen and St. Andrews.
King's College Medical School to Glasgow.

CHEMICAL IMPORTS OF THE UNITED STATES

IN the United States, according to a report of the Chemical Division of the Department of Commerce, imports of chemicals and related products, including gums, resins, drying oils and drying seeds, increased steadily during the first half of the current year and recorded a gain of 18 per cent. over receipts of such products in the corresponding months of 1938.

Receipts for these materials reached a total value of $90,000,000 in the current year period, against $76,473,000 in the corresponding months of 1938, with fertilizer materials making up 24 per cent. of the total;

drying oils and drying oil seeds, 21 per cent.; medicinal materials and crude drugs, 10 per cent.; and gums, resins, balsams and waxes, 8 per cent.

Imports of fertilizer materials, not including tankage, showed little change in the first half of the current year, compared with the same period of 1938, remaining at about 800,000 tons valued at about $19,000,000, but imports of tankage increased sharply to 33,072 tons valued at $1,224,000 from 13,648 tons valued at $432,000 in the first half of last year.

Some changes occurred in the drying oil and drying oil seed group, due to disturbances in China, which reduced that country's exports of tung oil, but the aggregate for the whole classification advanced approximately 13 per cent., due to heavier imports of perilla and oiticica oils and flaxseed. In this group imports of tung oil decreased from 50,400,000 pounds in the first half of 1938 to 39,500,000 pounds in the current year period; but receipts of flaxseed increased from 7,383,000 to 10,763,000 bushels; perilla oil, from 15,571,000 to 23,000,000 pounds, and oiticica oil, from 1,360,000 to 9,019,000.

Among the medicinal and related product materials, receipts of cod-liver oil increased from 2,381,500 to 2,896,500 gallons; crude drugs, including cinchona bark, from $3,906,000 to $4,744,000 in value; and medicinal materials, including cinchona products, from $2,323,000 to $2,593,000, according to preliminary statistics.

Imports of coal-tar products increased sharply in the first half of the year to $10,742,000 in value from $7,330,600 in the same months of 1938, due to the heavy receipts of dyes, colors and stains from Germany.

Other items on the chemical and related product import list recording gains in the first half of the current year, compared with the 1938 period, included beeswax, receipts of which increased in value from $298,000 to $447,500; gums, resins and balsams, from $4,825,000 to $5,828,000; carnauba wax, from $2,494,000 to $2,844,000; vegetable wax, from $152,000 to $347,000; essential oils, from $2,285,000 to $2,755,500; vegetable dyeing and tanning materials, from $2,466,000 to $3,573,000; industrial chemicals, from $7,822,000 to $9,899,000; and soap and toiletry raw materials, from $1,132,800 to $1,310,000.

Other items recording decrease included glue stock, imports of which declined in value from $1,539,500 to $919,680; agar-agar, from $201,000 to $158,000; and industrial explosives, from $475,500 to $270,000.

BIOLOGICAL ABSTRACTS

Biological Abstracts is undertaking a more complete abstracting and segregation of the current research literature in bioclimatology and biometeorology. The section Bioclimatology-Biometeorology will appear within the section Ecology, and will be under the editorship of Robert G. Stone, of the Blue Hill Observatory of Harvard University.

Attention is called to the increasing interest in climatic and meteorological factors in their relation to biology, medicine and agriculture. It is pointed out that ecologists have long appreciated the importance of temperature, humidity, radiation, barometric pressure, wind movement and meteorological factors generally as important factors in controlling the distribution and abundance of animals and plants, and that foresters, horticulturists and entomologists have likewise been concerned with the interrelationships of climatic and meteorological factors to the organisms with which they work. The developments of air conditioning and aviation have brought other research groups into the field, including individuals and groups the results of whose work frequently appears in periodicals not commonly consulted by biologists. The announcement reads:

> In all civilized nations diverse research groups have sprung into being which, though they often devote much attention to the same fundamental natural forces, still work in practical isolation from each other, with a different background of training and associations, belonging to different societies meeting at different times and places, publishing in different journals, reading different literature, investigating different types of things. These groups, however, are beginning to apply common ideas and common methods to the study of situations that are basically similar. For example, techniques and concepts derived from a study of the influence of weather factors on the spread of influenza or the common cold are likely to have a very high transfer value as applied to the study of the spread or survival of plant disease or economic insects. Conversely, it should be possible for research workers in the field of public health to make use of many findings of the entomologists, foresters, ecologists, plant pathologists and other biological groups.
>
> The abstracting journals of broad scope, like *Biological Abstracts*, are admirably suited to the sort of synthesis of fundamental knowledge that this situation demands. In inaugurating this service *Biological Abstracts* will be fulfilling one of the functions for which it was originally intended: that of providing an effective tool for research workers by coordinating the literature of border-line fields.

Under the sectional publication plan this material will be found, at present, not only in Section A, General Biology, but also under section B, Experimental Animal Biology; Section D, Plant Sciences, and Section E, Animal Sciences.

THE SCIENTIFIC PROGRAMS OF THE CHICAGO MEDICAL SOCIETY

THE Chicago Medical Society is planning a series of all-day programs for the consideration of various diseases to be held on the third Wednesday of each

month from October through April. In the morning and afternoon, there will be clinics, demonstrations, lectures and round table discussions on the general subject selected, certain aspects of which will be presented at the evening meeting. The day-time part of the program will be held in one or another of the teaching institutions of the city, but will be a program of the society presented in the institution, rather than a program of the institution presented to the members and guests of the society. The evening meetings will be held at 8:30 P.M. at the Chicago Woman's Club Theater on Eleventh Street near Michigan Boulevard. Detailed programs will be furnished each month.

The topics to be considered at these meetings are as follows:

October 18—Fractures at the Cook County Hospital; The Treatment of Skull Fracture, Harry E. Mock, Chicago.

November 15—Nutritional Deficiency Diseases at Thorne Hall on the Chicago Campus of Northwestern University; The Vitamin B Complex and Pellagra, Tom D. Spies, Cincinnati, Ohio.

December 20—Cardiovascular-Renal Diseases at One of the Institutions in the West Side Medical Center; Arteriosclerosis Obliterans: The Modern Conception of its Social Significance, Diagnosis and Treatment, Irving S. Wright, New York City.

January 17, 1940—Industrial Medicine and Traumatic Surgery at St. Luke's Hospital; The Evaluation of Disability Due to Cardiovascular Disease.

February 21—Topic and speaker to be selected.

March 20—Endocrinology at the University of Chicago Clinics; The Misuse of Biologicals in Medical Practice.

April 17—Obstetrics and Care of the New Born; Maternal and Infant Mortality in Chicago, 1935–39.

A luncheon for members and guests will be arranged at or near the institution in which the clinical program is to be presented, and a dinner will be held at the Chicago Woman's Club before the evening meetings.

THE RELATIONS OF SCIENCE TO SOCIETY

THE American Association for the Advancement of Science has adopted two minutes on the relations of science and scientific men to the social order, which are here reproduced. The first was adopted at the Boston meeting in December, 1933, the second at the Indianapolis meeting in December, 1937.

The American Association for the Advancement of Science feels grave concern over persistent and threatening inroads upon intellectual freedom which have been made in recent times in many parts of the world.

Our existing liberties have been won through ages of struggle and at enormous cost. If these are lost or seriously impaired there can be no hope of continued progress in science, of justice in government, of international or domestic peace; or even of lasting material well-being.

We regard the suppression of independent thought and of its free expression as a major crime against civilization itself. Yet oppression of this sort has been inflicted upon investigators, scholars, teachers and professional men in many ways, whether by governmental action, administrative coercion or extra-legal violence. We feel it our duty to denounce all such actions as intolerable forms of tyranny. There can be no compromise on this issue, for even the commonwealth of learning can not endure "half slave and half free." By our life and training as scientists and by our heritage as Americans we must stand for freedom.

WHEREAS, Science and its applications are not only transforming the physical and mental environment of men, but are adding greatly to the complexities of their social, economic and political relations; and

WHEREAS, Science is wholly independent of national boundaries and races and creeds and can flourish permanently only where there is peace and intellectual freedom; now, therefore, be it

Resolved, By the Council on this thirtieth day of December, 1937, that the American Association for the Advancement of Science makes as one of its objectives an examination of the profound effects of science upon society; and that the Association extends to its protype, the British Association for the Advancement of Science, and to all other scientific organizations with similar aims throughout the world, an invitation to cooperate not only in advancing the interests of science but also in promoting peace among nations and intellectual freedom in order that science may continue to advance and to spread more abundantly its benefits to all mankind.

SCIENTIFIC NOTES AND NEWS

A TESTIMONIAL dinner marking the completion of the first ten years of the administration of Dr. Alexander G. Ruthven as president of the University of Michigan will be given on October 27. Two thousand, six hundred alumni and others are expected to be present. Dr. Ruthven was from 1911 to 1929 professor of zoology at the university.

DR. LEE DE FOREST was honored at the New York World's Fair on September 22 at ceremonies marking Radio Pioneers Day. He addressed scientific men in Paris, via a short-wave broadcast from the French Pavilion. He was the guest of honor and made an address at a luncheon at the Ford exhibit.

THE *Journal* of the American Medical Association reports that the American Legion of South Carolina will confer its 1939 plaque for distinguished service to the state on Dr. Robert Wilson, dean and professor of medicine at the Medical College of the State of South Carolina, Charleston.

THE French Academy of Medicine has awarded the

Grand Prix Prince Albert I de Monaco to Dr. Jules Lefèvre, professor of general agriculture at the Institute of Agronomy, Paris, for his work on biology during the past fifty years.

OFFICERS of the National Association of Science Writers have been elected as follows: William Laurence, of *The New York Times, president;* Robert Potter, Science Service, *vice-president;* Jane Stafford, Science Service, *secretary;* Stephen J. McDonough, Associated Press, Washington, *treasurer.*

V. K. BROWN, director of recreation for the Chicago Park District, was elected president of the American Institute of Park Executives at the recent Philadelphia meeting. He succeeds Samuel N. Baxter, of Philadelphia.

S. F. MARKHAM was elected president of the Museums Association of Great Britain at the recent Cheltenham meeting; Lord Leverhulme and Sir Evan Charteris were elected vice-presidents. The annual meeting in 1940 will be held in Liverpool.

G. ARNOLD, of the National Museum of Southern Rhodesia, has been elected president of the African Museums Association. The meeting in 1940 will be held at Capetown.

AT the annual meeting of the American Neisserian Medical Society held in Milwaukee on June 22, it was voted that the name of Dr. P. S. Pelouze, of Philadelphia, be suggested to the Amory Fund Committee for consideration in connection with the 1940 award. Owing to a misunderstanding it was reported in SCIENCE that the award had been made to Dr. Pelouze.

DR. W. R. HORLACHER, head of the department of animal industry at the University of Arkansas, has become dean of the College of Agriculture and director of the station and of the extension service. H. E. Thompson, head of the Farm Security Administration in Arkansas, has been appointed assistant director of the extension service.

IN the department of zoology of the University of Illinois, Professor Victor E. Shelford has been appointed acting head of the department. New appointments include Assistant Professor C. Ladd Prosser, of Clark University, in charge of general physiology, and Dr. Hurst H. Shoemaker, instructor. The following promotions have been made: Frank B. Adamstone, to an associate professorship; B. Vincent Hall, to an assistant professorship, and Lester Ingle, to an associateship.

DR. WALTER H. BUCHER, professor of geology and chairman of the department of geology and geography at the University of Cincinnati, and Dr. Stephen P. Burke, consulting engineer at Washington, D. C., have been appointed visiting professors at Columbia University. Dr. Bucher will conduct courses in geology, and Dr. Burke will have charge of classes in chemical engineering.

DR. RALPH W. PHILLIPS, physiologist in the Division of Animal Genetics of the Bureau of Animal Industry at Beltsville, Md., has been appointed head of the department of animal husbandry at the Utah State Agricultural College. He will conduct research on the physiology of reproduction and nutrition of range live-stock animals. Dr. Phillips expects to take up the work on November 1.

AT the University of New Hampshire, C. Floyd Jackson, professor of zoology and entomology and dean of the College of Liberal Arts, has been appointed director of the newly established biological institute; Dr. A. F. Yeager, assistant professor of horticulture at the Michigan State College, has become head of the department of horticulture, and Dr. Daniel Clark Lewis, instructor of mathematics at Cornell University, has been appointed assistant professor of mathematics.

DR. THOMAS A. SHALLOW, of Philadelphia, has been elected to the Samuel D. Gross chair of surgery at Jefferson Medical College, Philadelphia. Dr. Shallow is neurological surgeon of the Philadelphia General Hospital and head of the surgical department of Jefferson Hospital. Dr. George P. Muller has been appointed Grace Revere Osler professor of surgery.

DR. ORREN W. HYMAN, dean of the College of Medicine, has been appointed dean of administration at the University of Tennessee. Dr. Conley H. Sanford, associate professor of medicine, has been made professor and head of the department of medicine to succeed Dr. James B. McElroy, who resigned recently because of ill health. Dr. Robert H. Miller, associate professor of anatomy, has been made assistant dean; Dr. Lathan A. Crandall, Jr., associate professor of physiology and pharmacology at Northwestern University, has been appointed head of the department of physiology, and Dr. Lucius C. Sanders, of Memphis, assistant professor of medicine.

THE reorganization of the School of Medicine of the Louisiana State University has resulted in the following appointments: *Dean,* Dr. Beryl Iles Burns; *Assistant to the Dean,* Dr. John Rudolph Schenken; other members of the executive committee are: Drs. Urban Maes, Edgar Hull, Richard Ashman and James T. Nix.

DR. ARTHUR KORN, formerly professor at the Technische Hochschule, Berlin, known for his work in phototelegraphy, has been appointed professor of electrical engineering at the Stevens Institute of Technology. Professor Korn's experiments are said to

have led to the first transmission of a photograph on a telephone line and to the first wireless transmission of a photograph from Europe to America.

DR. HERBERT SHAPIRO, of Clark University, who was in 1937 Guggenheim Memorial Foundation fellow at the University of London, has been appointed instructor in physiology at Vassar College.

DR. J. M. WATKINS has been made assistant professor of agronomy and assistant research agronomist at the University of Delaware.

DR. JOSEPH CHANDLER MORRIS, of Princeton University, has been named visiting professor of physics at Newcomb College, Tulane University, for the present academic year. He will fill the temporary vacancy caused by the absence of Dr. Rose L. Mooney, who was recently appointed a Guggenheim fellow and who is now studying in Holland.

AN Associated Press dispatch dated September 22 reports that Dr. Ferdinand Augustus Silcox, chief of the U. S. Forest Service, had been offered by Secretary Harold L. Ickes the post of Under Secretary of the U. S. Department of the Interior, but that he had refused, writing, "that under the circumstances I should remain where I am." The report states that the long-standing Congressional controversy over the transfer of the Forest Service from the Department of Agriculture to the Department of the Interior influenced both the offer and the refusal.

DR. FOREST RAY MOULTON, permanent secretary of the American Association for the Advancement of Science, and Mrs. Moulton reached New York on September 18 on the American Republic liner *Brazil* after spending some weeks in South America.

DR. MELVILLE T. COOK, plant pathologist to the Agricultural Experiment Station of the University of Puerto Rico, has been granted leave of absence until June 30, 1940. He will spend the time in the United States.

DR. FRANK E. EGLER, assistant professor of botany at the New York State College of Forestry, Syracuse, has returned from Martinique, where he spent the summer in ecological investigations with the cooperation and support of the French colonial government. Problems with which he was directly concerned included the growing of mahogany, the restoration of the mangrove forests and the management of arid cattle ranges and watersheds.

APPLICATIONS must be on file with the United States Civil Service Commission at Washington, D. C., not later than October 10 for the positions of principal statistician, at a salary of $5,600 a year; senior statistician, $4,600; statistician, $3,800; associate statistician, $3,200, and assistant statistician, $2,600. Optional subjects for the examinations are: economics, mathematics, public health, sociology, social service, public administration, biological science and engineering and physical science. Further particulars can be obtained from the Civil Service Commission, Washington, D. C.

THE twenty-eighth meeting of the Italian Association for the Advancement of Science is scheduled to meet at Pisa from October 8 to 15.

ANNOUNCEMENT is made that the twenty-sixth French Congress of Hygiene will be held at the Institut Pasteur, Paris, from October 9 to 12. Dr. X. Leclainche is the general secretary of the congress.

THE eighth National Symposium for Organic Chemistry of the American Chemical Society will be held on December 28, 29 and 30 in the auditorium of St. Louis University. The speakers will include: Roger Adams, A. H. Blatt, F. F. Blicke, A. C. Cope, E. A. Doisy, Louis F. Fieser, Henry Gilman, Harold Hibbert, John R. Johnson, W. M. Lauer, Randolph T. Major, Rudolf Schoenheimer, Lee I. Smith and Wm. G. Young.

ACCORDING to the *Journal* of the American Medical Association, the School of Medical Sciences of Wake Forest College will be moved to Winston-Salem, N. C., and will become a four-year school. Funds adequate to develop the school to a capacity of two hundred students have been provided by the Bowman Gray Fund from the estate of the late Mr. Gray, of Winston-Salem.

DISCUSSION

IMPORTANT PALEOLITHIC FIND IN CENTRAL ASIA

A DISCOVERY of early human remains of outstanding importance has been made in the latter part of the previous summer (1938) by A. Okladnikov and his wife, young energetic Russian scientists, and may now be definitely reported. It is no less than a find of a Neanderthal child, with characteristic Mousterian implements and an old fauna, in a cave near Baisun, Uzbekistan, Central Asia.

The skeleton of the child lay in a regular burial, in a cave which, located in cliffs, had suffered no disturbance. The long and other bones were largely gone, but the skull and the lower jaw, while in pieces, were found capable of almost a perfect reconstruction, which was ably carried out, under Professor M. Plisetzky's direction, in the Anthropological Institute of the University of Moscow.

The writer was enabled to examine the remains, with the photographic and other records relating to

the find, and to get additional information from the discoverers themselves. The skull, with its lower jaw and all the teeth, is the most complete and in general the best Neanderthal cranium yet recovered. It belongs to a normally developed child 8 to 9 years of age. The vault is as well developed as that in the La Quina and Gibraltar children, the supraorbital region, face, lower jaw and teeth denote all unequivocally a Neanderthal specimen. The implements found with the body are typically Mousterian; and the photographic record of the work shows a highly creditable procedure.

Thus, unexpectedly, Central Asia furnishes a first-rate piece of evidence of early man, which is bound to have a great bearing on the concepts of human prehistory in the Old World, and will necessitate a material revision of notions relating to the Neanderthal phase of human antiquity. The easternmost localities of Neanderthaloid remains hitherto known were Palestine, Crimea and the Caucasus—the Uzbekistan find extends the territory far beyond this, and halves the distance from the western Neanderthalers to Peking Man.

Before the writer's departure from Russia Dr. Okladnikov furnished him with the essential details of the find, the first notice of which he published, under the title "Nakhodka neandertalca v Uzbekistanie," in the *Viestnik Drievnei Historii,* 1939, No. 7, pp. 256–7. They are briefly as follows:

In 1938, I was charged by the Marr Institute for the History of Material Culture, and the Committee for Conservation and Study of Cultural Remains attached to the Council of the People's Commissaries of the Uzbek SSR, to search for remains of the Stone Age in the Bukhara District, Uzbekistan, and to check information received about finds of stone implements of the neolithic type in the Daria River Valley. The exploration showed that caves and rock-shelters containing remains of prehistoric man exist in the Valley, and systematic excavations were made in one of the newly found caves, the "Teshik-Tash."

This cave is situated in the upper part of the Shirabad-Daria Valley, near the village Machai, 18 km NW of the town of Baisun. The Turgan River cuts here through the Baisan Tau Mountains, which reach a height of about 8,000 to 9,000 feet above sea-level, and are a part of the Gissar Mountain Range.

The Baisun-Tau Mountains consist of Jurassic limestone. They present many canyons, caves and rock-shelters, with a well-developed Karst landscape.

The Teshik-Tash cave is situated on the NW-slope of the Baisun-Tau, in one of the left-bank canyons of the Turgan-Daria River and high above its level. Above it, the juniper growth runs out, leaving high mountain steppes and subalpine lawns. The cave is dry. Its dimensions are 20 × 21 metres, height at the entrance 7 metres. Excavations of its floor showed that it had been inhabited by man only in the paleolithic time. We uncovered five strata with remains of ancient culture, separated by sterile layers. The total depth of the cultural deposits approximated 1.5 metres.

There were many splintered bones in the deposits. They belonged to deer, leopards, wild horses, wild goats (*Capra siberica*), wild boars (*Sus scrofa*), marmots, creepers and birds. Many bones showed scratches and cuts, others had evidently served as anvils for making stone implements. The latter were made on the spot, and mostly of local siliceous limestone. The finest tools were made of jasper, but good materials were scarce, and the inhabitants used also quartzite and even rough quartz.

With the animal bones were found typical mousterian-like discoid nuclei, characteristic flakes, cutting implements and scrapers of mousterian form, small pointed implements chipped on one side, and chips. Most of these objects were related to fireplaces—patches of ashes and carbonaceous matter with underlayer of intensely burnt clay.

The ancient inhabitants of the cave dwelt under the massive roof, by their fires. They made there their implements. They got their living mainly by hunting wild goats. Goat bones prevail in the osteological materials from the cave. Whole horns of huge size, often in pairs and conserving their junction, were found almost in all the layers.

But the most interesting find was that of a human skeleton. This was found directly beneath the first (from above) layer containing cultural remains, being covered by it and embedded in the underlaying sterile stratum. The bones were in a fragmentary state, and many parts of the skeleton had disappeared. What remained were portions of some ribs and of a few limb bones, and finally a skull with the lower jaw. The human bones were surrounded by five pairs of goat horns, three of them united, placed approximately in a circle. Evidently this was a regular burial.

The skeleton belonged to a child. The study of the skull, perfectly restored by M. M. Gerasimov, and that of the other bones, by the anthropologists of the Moscow Anthropologic Institute, shows that they possess all the characteristic features of the Neanderthal man, and approach closely the European Neanderthal remains of similar youth.

The find in the Teshik-Tash cave establishes for the first time the existence of artifacts belonging to the Mousterian period, and the presence of remains of Neanderthal man, in Central Asia.

The exploration of the Uzbekistan caves was resumed by Okladnikov and his wife towards the end of July, this summer. Meanwhile upper paleolithic and extensive neolithic sites have been found by these same two explorers (and in part seen by the writer) along the Angara River up to 75 miles north of Irkutsk; while other paleolithic finds of different ages are being signalled by other Russian explorers in the Urals, in the Crimea and in other western parts of the country.

The USSR authorities deserve the thanks of science for furthering these researches more actively than is now possible or done in any other country.

ALEŠ HRDLIČKA

U. S. NATIONAL MUSEUM

A SECOND HOUSEHOLD PALM, OMANTHE COSTARICANA

A NEAT little palm brought home in 1902 from mountain forests of eastern Guatemala was described in SCIENCE for August 6, 1937, as *Neanthe bella,* the first member of the palm order to prove well adapted for domestication as a house-plant, flowering and fruiting readily in living rooms, classrooms or laboratories, and opening this group to study as never before. The flowers of the two sexes are specialized and borne on separate plants, but simple methods of pollination have been devised, breeding-stocks are being established at several universities and experiment stations, and additional seeds or young plants are being supplied for educational, experimental or commercial propagation. Two detailed accounts have appeared, with photographs, "A Diminutive Palm from Mayaland," in *The National Horticultural Magazine* for January, 1938, and "Neanthe, a Palm for Genetic Study," in *The Journal of Heredity* for March, 1939.

Another attractive small palm obtained at San Jose, Costa Rica, in 1903, is related to Neanthe and tolerant of household conditions, but of cespitose habit, forming clumps like a bamboo. The creeping root-stocks may be divided, or cuttings may be rooted like "slips" of house-plants, a striking departure from Neanthe, which grows only from seeds. Other obvious differences are larger size and later fruiting, long-jointed trunks, closed leaf-sheaths, strongly veined pinnae and floral adaptations not previously reported. The principal diagnostic characters of the new genus Omanthe are the crassate style, accrescent perianth, excavate embryo, separate triangular male petals, sessile stamens, attenuate pistillode, plicate pinnae, evittate rachis and auriculate petiole-base.

The name Omanthe, meaning shoulder-flower, refers to the remarkably thickened upper part of the pistil, filling the female corolla and raising the stigma to the entrance of the flower, between the narrow recurved angles of the wide overlapping petals. The thickened shoulder may be described as a stylar cushion and compared with the large staminal cushion of Neanthe, the two structures doubtless serving similar functions in retaining moisture, but obviously not homologous. The staminal cushion of Omanthe is very small, the filaments obsolete and the anthers much exceeded by the tall conic-prismatic pistillode.

The type species is *Omanthe costaricana,* described by Oersted in 1858 as *Chamaedorea costaricana,* from the volcano Turrialba. The genus is represented in the U. S. National Herbarium from numerous localities in Costa Rica, including Guanacaste and Nicoya, also from Nicaragua and from the Chiriqui volcano in Panama. Outdoor plants at San Jose reach a height of 8 to 10 feet and form striking clusters of bright green foliage.

The leaf-sheaths are longer than in Neanthe, the petioles shorter and the leaf-blades larger; the pinnae, 17–20 on a side, more widely spaced, longer and more tapering, more curved and drooping and more prominently 5-veined, a single intermediate vein on each side stronger than the others, though weaker than the submarginal vein. The rachis and petiole uniform green underneath, lacking the pale stripe of many related palms. The mouth of the leaf-sheath has a triangular stipule-like tooth on each side, at the base of the petiole.

The inflorescences are developed below the leaves, the peduncle slender with 7 or 8 joints, the second extremely short, 5 or 6 joints with narrow scarious spathes; the axis emergent, relatively short; branches 20–35 in the male, 10–15 in the female, the male branches longer and the flowers closer together, though not crowded; base of branches often decurrent, the subtending bracts represented by broad short rims. Female calyx and corolla accrescent and persistent, yellow with brown margins. Staminodes minute, usually 3, opposite the petals, oblong or tapering, the apex thin and pale, truncate or retuse, doubtless a rudiment of the anther.

Fruits broadly oval, nearly round, turning black from green, only the point of attachment yellow like the branches; exocarp firmly fleshy, forming a rather tough rind coarsely wrinkled in drying, lined with a thin green pulp and a close network of fine mesocarp fibers. Seeds spherical, marked on each side by a widely arcuate groove, the embryo subbasal, the cavity protected by a specialized operculum minutely apiculate outside and an endosperm lining with a central prominence accommodated by a cavity in the base of the embryo. Seedling with first leaf simple, broadly v-shaped.

A single large inflorescence had somewhat larger fruits and more accrescent perianths, many of these with four calyx-lobes and only two petals, a notable example of metaphanic variation or replacement in a group generally adhering regularly to its basic number three. The petal that subtends the stigma often is smaller than the other two, and where only two petals are present the stigma usually is exposed, though not in all cases. On a greenhouse plant of Omanthe two forms of abortive fruits were developed from pollination with Neanthe and another related palm, as shown in the *Journal of Heredity.*

Only a few clusters of Omanthe, without flowers or seeds, were seen at San Jose in June, 1903, and only a female plant obtained, but now this palm has be-

come a popular ornamental, variously used in open plantings, hedges, screens and arbors. "Pacaya" is the local name, though also applied to related kinds, more properly to those that have edible inflorescences. The present status of the palm in San Jose was observed by Mr. Loren G. Polhamus, of the U. S. Department of Agriculture, in December, 1938. Flowers of both sexes were collected, but no seeds were found, and even in March, 1939, when another visit to Costa Rica was made, only green fruits had developed. A rather definite seasonal habit is indicated, flowering in December and ripening its fruits in May, the fleshy pericarp doubtless attracting birds and the seeds scattered before the summer rains.

Through the kindness of Mr. W. E. Klippert, of the Goodyear Rubber Plantations Company, it was possible to arrange for ripe fruits to be sent, and a generous shipment reached Washington in May, 1939. The seeds were in excellent condition, were planted at once and germinated promptly. By the middle of July many seedlings had appeared, and a few had reached the stage of opening their first leaves. Thus adequate tests are in prospect at field stations and with private growers, to determine the value of the palm for household use with Neanthe and also for outdoor planting in Florida and California.

O. F. COOK

U. S. DEPARTMENT OF AGRICULTURE

FRESH-WATER MEDUSAE FOUND IN KIATING, SZECHUEN, CHINA[1]

Two species of fresh-water medusae were found in a pond along Tatu River, Kiating, Szechuen, China, in association with tadpoles, green algae, diatoms, protozoa, rotifers, small Crustacea and other aquatic forms. The pond is about four hundred meters long, thirty meters wide and two meters deep, the bottom of which is covered by sand and gravel. The water is fairly clear, and at the time of the discovery of the medusae its temperature and hydrogen ion concentration were 12° C and 7.2, respectively.

One species, possibly a variety of *Craspedacusta sowerbii,* was found on January 14, 1939. A large number of them has been found since then, mostly on sunny days. The average diameter of the umbrella measures about 2.2 cm during expansion and 1.6 cm during contraction, although much smaller young and un-mature forms were observed. The manubrium is rather long; its ratio to the diameter of the umbrella is about 1:1.5. The height of the umbrella varies, of course, with the diameter as well as the activity of the animal, whether it is in expansion or in contraction. The number of tentacles is not constant, being variable from 259 to 272. They are of seven kinds in respect to their length, arranged radially around the margin of the umbrella with more or less regularity. Located at the base of the velum and inside of the small canals (which are in direct connection with the circumferential canal) are sense organs whose number varies from 129 to 146. The gonads as four greenish pocket-like outgrowths are situated at the junction of the gastrovascular cavity and the four radial canals.

The other species found in the same pond on February 12, 1939, is much smaller, whose average diameter is about 7. cm during expansion and .45 cm during contraction. The manubrium is relatively shorter. Its ratio to the diameter of the umbrella is about 1:2. The number of tentacles varies from 44 to 115, and they are of four kinds in respect to their length. Sense organs and gonads are located at the same positions as those of the preceding species, but the number of sense organs is less, only 29 to 71. So far, only four such specimens were found.

It might be interesting to note, in view of the observations made by Powers,[2] that the medusae we collected on January 14 have been living since in our unaerated aquarium, in which, however, the water is constantly changed, without showing any visible abnormality.

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ANTHELMINTIC ACTIVITY OF FRESH PINEAPPLE JUICE

THE use of latexes from Ficus species as anthelmintics has been known for a very long time. Robbins[1] and Walti[2] as well as others have shown that the enzyme ficin which they obtained from some of these latexes was the active agent responsible for the digestion of the parasites.

Since ficin, papain and bromelin belong to the class of so-called papain enzymes, it occurred to the authors that the bromelin of pineapple juice might exhibit anthelmintic activity similar to that of the ficin of the latexes. On looking over the scientific literature on pineapple juice no reference was found on the matter. However, it has been reported that the juice has been used in folk medicine as an anthelmintic.[3]

Living *Ascaris lumbricoides* and *Macracanthorynchus hirundinaceus,* obtained from hog's intestines, were incubated at a temperature of from 35° to 40° C. with pineapple juice freshly squeezed from a Cuban

[1] The detailed description of the organisms will appear shortly in the Biological Science Series of the Science Reports of National Wuhan University.

[2] Edwin B. Powers, SCIENCE, 88: 498, November 25, 1938.

[1] B. H. Robbins, *Jour. Biol. Chem.,* 87: 251, 1930.

[2] A. J. Walti, *Jour. Biol. Chem.,* 119, *Sci. Proc. Soc. Biochem.,* 31. Ci., 1937.

[3] K. M. Nadkarni, "The Indian Materia Medica," p. 62. Bombay, 1927.

pineapple. At the end of 24 hours both parasites were completely digested, while controls incubated in heat-inactivated pineapple juice and in saline solution were very lively and active.

The results obtained indicate that the juice possesses enzymatic activity similar in nature to that of some Ficus latexes, and therefore there is some scientific basis for its use as an anthelmintic.

The much wider availability and cheapness of fresh pineapple juice suggest it as a more practical source of non-toxic, ficin-like anthelmintic.

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QUOTATIONS

THE VOICE OF SCIENCE

ONCE more the burden of war is laid upon us. Once more, as in 1914, the cynical disregard of Germany for the rights of small nations has constrained the British people to take up arms in the cause of justice and fair dealing in international relations. The challenge of the German Reich has been accepted reluctantly, and with no illusions as to the nature of the glories of modern warfare, only after every effort to secure a peaceful but equitable settlement of the differences between Germany and Poland has failed. It has been accepted with full realization of the gravity of every implication of the decision. But in turning to war as the last resort, the British people has acted with a unanimity such as never before in its history, and with a grim determination that no effort shall be spared in the endeavor to ensure that the cause which it holds just shall prevail.

From 1914–18, the Allies opposed dynastic ambitions in the interests of the freedom of peoples. No longer were the people to be the pawns of the political intrigues of their rulers. The world, it was said, was to be made safe for democracy—words that now have a mocking ring. In 1939, the canker has sunk deeper. It is not merely political liberty that is at stake, though that too is jeopardized. It is the spirit of man.

In no previous war has science played so great a part as that which will be demanded of it in the struggle that is at hand. For a time, while the issue hangs in the balance, it is the duty of the man of science to lay aside his just misgivings whether the greatest force of the human intellect should thus be harnessed to the forces of destruction. For the moment, the interests of pure science as an intellectual pursuit and discipline must remain in abeyance. The energies, the abilities and the knowledge of each and every individual with scientific training must be directed without remission to the service of the Allied cause. Nevertheless, the end to be attained, and the end which science should hold ceaselessly before the eyes of the Allied peoples, is not destruction, but a constructive ideal—to ensure in the future such conditions as will make possible the advancement of all the peoples of the world without discrimination, according to the status and the traditions of each, in the light shed by reason and scientific knowledge. To keep alive the aims of science in furthering the pursuit of truth in the universe and the relation of that truth to the developments of man's nature, without regard to tribal and racial distinctions, should be, indeed, must be, the ultimate function of the scientific thinker, whatever may be his more immediate preoccupations.

As to the form in which that ideal will find embodiment, at the moment, in the turmoil of initial operations, it is too soon to attempt a forecast; but that it is no idealist's dream is certain. The failure of the League of Nations as a political organization has cast discredit in the popular mind on such forms of international cooperation. Possibly the League of Nations came before its time, and this has obscured in the popular verdict the enormous value of its scientific work in the study of social and economic problems, and the progress which has followed, where the practical application of the solutions suggested has not conflicted with the trends of nationalist development. To extend the fields in which such cooperation between peoples may be applied is the task of the future, when the time comes, as it surely will, for reconstruction.—*Nature.*

SCIENTIFIC BOOKS

ELECTROMAGNETICS

Electromagnetics; a Discussion of Fundamentals. By ALFRED O'RAHILLY. xii + 884 pp. Longmans Green and Co., 1938. 42/– net.

ANY one who has attempted to write a logical presentation of electromagnetics is quite aware of the difficulties and so should welcome this essay in constructive criticism published by the Cork University Press.

A good amplified presentation is given of the usual mathematical analysis and the existence of different views is shown by numerous quotations from the writ-

gs of prominent authors. In some cases the views of writer are only partially expressed in the sentence uoted, and it is not clear what part the quotation is tended to play in the discussion. In some other cases e quotation serves as a definition; as, for instance, hen a physical theory is defined, after Duhem, as a ystem of mathematical propositions deduced from a mall number of principles whose object is to repre- nt a group of experimental laws as simply, com- pletely and exactly as possible. Such a definition akes constructive criticism a natural part of theo- etical physics, for every presentation of a theory must e examined to ascertain how far the desired perfection as been obtained. Duhem's "sole test of a physical heory" is mentioned and reiterated in the following uotation from Dirac's "Principles of Quantum Me- hanics," p. 7. "The only object of theoretical physics to calculate results that can be compared with ex- periment; and it is quite unnecessary that any descrip- tion of the whole course of the phenomena should be given." This statement, taken alone, seems too restric- tive unless there is an intention to distinguish between heoretical physics and mathematical physics. The hief aim of the mathematician is to find out how to ake calculations and to construct a language of sym- ols which will make it possible to think clearly about hysical phenomena and to formulate the conventions nder which the comparisons with experiments are to e made. The way to make calculations is often far rom evident; it is important, moreover, to be able to hoose an expeditious way and to be able to judge whether it is worth while to make the calculations. Mathematicians are glad to welcome any device or means of representation that may help them in their difficulties.

In an attempt to clarify the situation produced by the use of the word aether in at least three different senses the author recommends the use of the word schesis to denote the framework of reference used in the formulation of the electromagnetic equations. The absolute velocities occurring in these equations are then described as schesic velocities. With this proposi- tion the reviewer is wholly in sympathy. The term absolute seems too drastic for the velocities in the scheme of representation that has been found most con- venient. It should be emphasized also that relative velocity can only be defined when a scheme of repre- sentation has been chosen.

The reviewer would go further and recommend that the word aether should now be restricted to the sense in which it has become associated with the ideas of Heraclitus, who regarded everything as being in a state of flux and compared matter with a flame which burns or transforms the aether. As Heraclitus emphasizes the idea of force and the present author endeavors to found electromagnetics on the force formula between two moving electrons he may be regarded as a follower of Heraclitus who has an open mind with regard to the exact law of force, since he discusses the law of Ritz as well as that of Liénard and shows that Ritz's law ac- counts for some phenomena quite well.

Some writers may, of course, prefer to still associate the word aether with the "indeterminate" of Anaxi- mander or the starry firmament. Thus Livens says in a portion of the passage quoted on page 630. "What happens in the space between (space is that something which can be occupied by matter) we do not and can not know."

The idea of space seems, however, to be inseparably connected with some scheme of representation. Any one familiar with the theory of geometrical transfor- mations knows that two points which are contiguous in one representation may be separated in another. It is unlikely that there is an exact one to one corre- spondence between the descriptions of the universe obtained in different laboratories when, according to one description, there is an acceleration of one labora- tory relative to the other. In actual life correspon- dences are seldom exact over a great range. The mathematical estimate of the closeness of fit of a corre- spondence may well play a part in an attempt to define pleasure and pain, good and evil.

The idea of empty space is just as difficult as that of an indeterminate aether. A distance between two points can only be measured by placing a yardstick or other measuring device in the "vacant region," in one sense, then, the interval has no existence until the yardstick is in place.

The fundamental electromagnetic equations do not require time to be associated permanently with each point of the framework arbitrarily chosen for a scheme of representing location. The equations merely state that when *a* time has been associated with each point according to some continuous law, then two flux rela- tions hold. The equations do not even involve the velocity of light. This enters only when an attempt is made by the introduction of constitutive relations between the four electromagnetic vectors to account for observed physical phenomena.

A theoretical physicist is sometimes satisfied with a physical theory when calculated results agree with experiment. In some cases, however, the calculated results depend only on the characteristics of the partial differential equations used in the theory and may be the same in innumerable other theories in which the partial differential equations have the same characteristics. The mathematician can not then be satisfied by a simple agreement with experiment. He must scrutinize a theory carefully to ascertain what features of the theory are really confirmed by experiment.

The book under review contains discussions of many matters. Relativity and other recent theories are discussed. The ideas of Einstein and Maxwell are criticized. The author has little respect for authority, and this alone may entice readers to buy the book. The idea of localized energy is regarded as useless except in the case of radiation and the idea of stress in a medium is regarded as not helpful. The idea of contact action is just as difficult to comprehend as that of action at a distance.

H. BATEMAN

THE PHILOSOPHY OF PHYSICS

On Understanding Physics. By W. H. WATSON. Cambridge University Press, 1938.

THIS book is one more indication that interest in what has been variously termed the philosophy of physics or the logic of physics continues unabated. Sooner or later every physicist succumbs to the temptation to probe more deeply into the foundations of physical theories in the attempt to associate more meaning with what he is doing. The ultimate advantage of this procedure is not that it settles anything but that it does place certain problems in a clearer light. In some measure it also affords physicists an opportunity to clarify their philosophical tastes.

The author of the present volume believes that philosophy has great value in clarifying physical problems, but he also makes clear his opinion that the only kind of philosophy valuable for this purpose is that confined to the study of the logic of language. This sort of philosophizing has recently received much attention through the work of Wittgenstein and also the so-called Vienna circle of logical positivists. The author acknowledges his debt to Wittgenstein for the original stimulus to the present work. The first two chapters of the book are largely devoted to an expression and defense of the view-point that "the function of philosophy . . . is to clear up an understanding of the use of symbolism" and that psychology has little or nothing to do with the logic of physics.

The rest of the volume consists of four not completely integrated essays embodying the application of the author's ideas to various physical theories. There is indeed a common thread running throughout the discussion, namely, the emphasis that in its description of experience physics employs various methods of representation depending on the problem in hand. Unfortunately since the author does not make precisely clear what he means by a "method of representation," the reader will be forced to place his own interpretation on the treatment. The reviewer has the impression that *any* physical theory is an attempted representation of nature. On this view the author appears to be trying to say that whenever we have constructed a physical theory, in every application of the theory we must be careful to preserve consistency with the definitions and postulates of the theory and not try to mix in ideas from another and different theory. It is unlikely that physicists will disagree with this view.

In an interesting chapter on the "Nature of Mechanism" the author makes a few trenchant remarks about causality and points out that the wide-spread belief that quantum theory has abandoned causality is based on a misconception of the physicists' interpretation of this concept. It should perhaps be emphasized that to the author mechanism means simply the determinateness of physical theories, *i.e.*, the fact that theories make *precise predictions* from their postulates. It is not confined to mechanical or dynamical theories as commonly understood.

The last two chapters contain discussions of the concepts of substance and motion and certain aspects of the use of symbolism in mechanics and electricity. Most of the applications here are to classical physics.

The book as a whole is by no means easy reading. The reviewer feels that a closer integration of the various chapters would have enabled the reader better to grasp the gist of the author's admittedly carefully considered opinions and analysis of fundamental questions in the logic of physics.

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MEADOW AND PASTURE INSECTS

Meadow and Pasture Insects. By HERBERT OSBORN. pp. i + viii, 1 + 288, 100 text illustrations. The Educators Press, Columbus, Ohio, 1939.

THE meadow and pasture lands of the country are an important part of the agricultural area of the country. They comprised in the West in 1909 over 80 per cent. of the area and about 60 per cent. of the value of all crops in that part of the country.

This volume presents the first comprehensive account of the part insects play in reducing forage crops, especially grasses. There have been a number of excellent publications upon some of the more injurious species affecting these crops. It has remained for the author to bring together the results of his studies of grass-infesting species extending over a period of more than fifty years. He has been led to conclude that a reduction of nearly 50 per cent. in the forage after land has been in grass three or four years is largely due to insect levies. This is certainly of much practical importance to all owners of grazing land and all owners of live stock, particularly since the author discusses conditions which favor the multiplication of these pests and outlines practical methods for reducing losses of this character.

The ecologist will find much of interest in the volume in the extended discussion of the ecology of the meadow.

The author deals first with the physical factors of the meadow environment and secondly biological factors, the two producing a most important and far-reaching complex, admirably presented in diagrammatic form on page 41. It is necessary to give these factors careful study if practical methods for the reduction of injuries are to be worked out. The summary account of the animal groups of the meadow fauna is another interesting and practical phase.

The entomologist, aside from the general discussion of injuries, ecology and control, will find the accounts of different groups of insects occurring in meadows and pastures comprehensive and suggestive. This is particularly true of the Hemiptera-Homoptera, the group with which the author is most familiar. The book contains excellent illustrations and biographical data concerning numerous species, much of the information resulting from the author's investigations. This book is a handy source of information concerning these numerous important and largely unknown forms. The more technically minded will find here and there long lists of insects taken in various environments. There is also an extended bibliography and an excellent index which adds much to the value of the book.

The book is a valuable contribution to our knowledge of meadow and pasture insects. The author is to be congratulated upon the admirable and convincing presentation, while the publisher has done much to present this information in an attractive form.

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SOCIETIES AND MEETINGS

FUNGI AND FUNGOUS DISEASES

FOR the first time at an International Congress for Microbiology a special section was organized to consider fungi and fungous diseases. Dr. R. A. Harper, emeritus professor of botany at Columbia University, and Dr. Fred D. Weidman, professor of dermatological research at the University of Pennsylvania, were co-presidents of this section. Dr. B. O. Dodge, of the New York Botanical Garden, served as convener. Seventy-seven papers were presented. In spite of the fact that many foreign delegates were prevented from attending by the outbreak of the European war, twelve papers were read by foreign delegates representing Belgium, Brazil, Canada, Ceylon, England, Holland, Scotland, Sweden and Uruguay. The large number of papers submitted made it necessary to divide the section into two divisions, and eight sessions were held. Interest in the programs was evidenced by the large attendance at the meetings, and at one session on "Growth Substances" there was "standing room only."

As this was one of the first scientific meetings in which students of animal and veterinary medicine and students of plant pathology participated, a symposium was held on host parasite relationships for the purpose of comparing the processes of fungus infections of plants and animals. It was organized from the point of view of the animal kingdom by Dr. Fred Weidman, of Philadelphia, and the point of view of the plant kingdom by Dr. E. K. Stakman, of St. Paul. Papers were presented discussing: (1) Etiology of pathogenesis; (2) tissue reactions; (3) natural resistance, including immunity. It was apparent that further exchange of views of this sort would prove stimulating to workers in both fields.

On two mornings joint meetings were held with Section II (microbiological chemistry and physiology) on the subject of growth substances for microorganisms. These concerned mostly the effect of various elements in the nutrition of fungi and bacteria. Under the able direction of Dr. W. J. Robbins, of the New York Botanical Garden, speakers from the fields of chemistry, physiology, bacteriology and mycology were brought together for the discussion of the effects of these elements on the growth of organisms.

Under the direction of Dr. B. O. Dodge another program was devoted to sex, variation and genetics of the fungi, while Dr. M. Levine, Montefiore Hospital, New York City, sponsored a third session on the effects of microorganisms and chemical substances on atypical growth in plants. The latter papers concerned chiefly the production of plant tumors by bacteria or chemical agents. Another session was held jointly with Section I (Variation in Taxonomy) at which the classification and nomenclature of the Actinomycetes and yeast-like fungi were discussed in a number of papers. As a result of this discussion it was recommended that a committee be appointed to report at the next congress on the possibility of adopting some uniform nomenclature for the pathogenic fungi.

A number of papers were presented discussing various fungus diseases of man, including four papers on the ringworm infections and two on histoplasmosis. Dr. Carrion, of Puerto Rico, presented a study of the fungi of chromoblastomycosis, and Dr. W. A. E. Karunaratne reported a series of 104 cases of Rhinosporidiosis.

Dr. B. O. Dodge presented one of the main addresses of the general session of the congress on the subject of "Some Problems in the Genetics of the Fungi."

J. GARDNER HOPKINS
J. S. KARLING
Secretaries

SPECIAL ARTICLES

THE ROLE OF MICROORGANISMS IN THE CONSERVATION OF THE SOIL

CONSIDERABLE public attention has been focussed in recent years upon the problem of soil conservation, largely because of the effort made by the Federal Government to initiate large-scale investigations and to establish soil conservation agencies and special experiment stations in all parts of the country. Most of the investigations in this field have been largely based upon agronomic approaches and practical methods for preventing soil and water losses. Although some attention has been paid to the physical and chemical soil conditions, comparatively little consideration has been given to the possible role of the numerous soil-inhabiting microorganisms in the process of soil conservation. It is also generally recognized that soil organic matter, with which the soil organisms are intimately connected, plays an important part in conserving the soil; however, little is known as to whether this phenomenon is due to the organic matter as a whole or whether only a certain fraction of the organic matter is involved in the process.

A consideration of this important national problem, from a microbiological point of view, brings forth several phases which deserve careful investigation, namely: (1) the function of the cells of microorganisms, especially the mycelium of the fungi and actinomycetes, as soil-binding agents; (2) the production by microorganisms, notably by bacteria, of specific substances, such as slimy materials, which aid in binding the soil particles; (3) the specific stage of decomposition of organic matter added to the soil when it is most active in bringing about a binding or aggregation of the soil particles; (4) the formation, as a result of decomposition, of chemical complexes, comprising certain humus constituents, such as the so-called "humic acid" compounds, which exert a physical or perhaps even chemical effect upon the inorganic soil particles.

In a series of studies carried out at the New Jersey Agricultural Experiment Station, an attempt has been made to throw light upon some of these problems. These studies comprise both laboratory and field investigations.

Because the soil microorganisms differ in the type of growth and in the nature of the substances synthesized, it is logical to suppose that some organisms will affect the physical properties of the soil to a different degree or in a different manner from others. In order to ascertain the extent of soil binding and aggregation brought about by microorganisms, artificial soils were employed consisting of sterile sand-bentonite and sand-clay mixtures. Sucrose or cellulose were used as sources of energy, and nutrient salt solutions were added. The artificial soils were adjusted to optimum moisture and inoculated with pure cultures of fungi and bacteria or with a soil infusion. After various periods of incubation, the contents of the flasks were analyzed, using certain procedures designed to show relative differences in the binding effect upon the soil particles.

Certain typical results are presented in Table I.

TABLE I

BINDING EFFECT OF MICROORGANISMS UPON THE FINE PARTICLES IN SAND-BENTONITE MIXTURES[1]

Energy source	Organism	Pipette method: Unbound material in 50 gm	Pipette method: Bound	Slope method: Unbound material in 50 gm	Slope method: Bound
		gm	per cent.	gm	per cent.
Sucrose	Control	2.12	0	1.1	0
"	*Rhizopus nigricans*	2.07	3	0.7	36
"	*Aspergillus niger*	1.60	25	0.3	72
"	*Azotobacter indicum*	1.57	26	0.45	60
"	*Bacterium fluorescens*	1.90	10	0.7	36
"	Soil infusion	1.76	17	0.6	45
Cellulose	Control	1.86	0	0.8	0
"	*Trichoderma köningi*	1.54	18	0.6	26
"	*Trichoderma+A. fumigatus*	1.61	14	0.65	21
"	*Trichoderma+Penicillium*	1.48	21	0.6	26
"	Soil infusion	1.11	41	0.45	45

[1] Incubation period, 23 days for sucrose cultures and 55 days for cellulose cultures.

They show beyond a doubt that soil microorganisms exert an important binding effect upon the fine soil particles and that the degree of binding depends on the organisms involved. The contents of the flasks containing the fungi showed that the whole mass of artificial soil was held together by an extensive mycelial network. When the material was dried, it fell apart in a granular state. The contents of the flasks inoculated with *Azotobacter indicum* were held together by the slimy substances produced by the organism. Similar results were obtained by the use of sand-clay mixtures.

It is well established that when fresh or decomposed organic matter is added to the soil it brings about favorable changes in the physical properties of the soil, with a tendency to decrease soil erosion. The favorable effect is believed to be due primarily to a mechanical binding of the soil particles by the organic matter and to an increased aggregation of the soil brought about by physico-chemical interactions between the organic matter and the soil constituents. Increased moisture-absorbing and moisture-holding capacities might also be a factor. These changes increase percolation and infiltration, which in turn decrease run-off and erosion. If there were no microorganisms in the soil to decompose the organic matter the effect would be largely mechanical. However, when fresh organic matter is added to the soil countless organisms immediately begin to decompose it. Decomposition products and substances synthesized by the organisms interact with the fine soil particles, causing them to

aggregate. The organisms themselves also tend to bind the soil particles.

Since plants and humus deposits differ in chemical composition, it is likely that organic matter from various sources will not affect the physical properties of the soil alike. In certain experiments designed to determine the effect of various typs of organic matter on the physical properties of the soil, related to soil erosion, a field soil was treated with alfalfa, straw, manure and peat material. At various intervals the total organic carbon, moisture-holding capacity, infiltration capacity and dispersion ratio were determined. The results showed that all four types of organic matter increased the infiltration capacity, with peat being most effective. Alfalfa, straw and manure brought about a rapid increase in the number of water-stable aggregates, as measured by the dispersion ratio, with alfalfa producing the greatest increase. Peat caused only a small increase in aggregation. After three months' decomposition, under favorable moisture and temperature conditions, the increase in aggregation had almost disappeared in the case of straw and peat; it was still apparent to some extent in the case of the manure and was quite marked in the alfalfa-treated soil.

In conclusion it may be stated that the role of microorganisms in soil conservation is highly important and is closely associated with the transformation of the organic matter added to the soil.

The detailed results of these experiments and the methods employed will be published in *Soil Science*.

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ON THE MOLECULAR WEIGHT OF THE TOBACCO MOSAIC VIRUS PROTEIN

IN recognition of the unreliability of the value of 17 million for the molecular weight of the tobacco mosaic virus protein, as calculated from the sedimentation constant[1,2] of $170\text{–}200 \times 10^{-13}$, Stanley[3,4,5] and his co-workers have recently attempted a correction for the molecular weight by a combination of the data obtained by means of the standard Ostwald viscometer and the Kuhn, the Eisenschitz and the Perrin equations. The assumptions were that one could estimate the value for the relative dimensions of the elongated particles from viscosity data, and that these relative dimensions could be used in calculating the asymmetry constant to be used in conjunction with the data obtained from the ultracentrifuge. It has been protested[5] that the failure of the protein-water system to follow the Poiseuill's and Fick's law is not of sufficient importance to impair the usefulness of these methods in determining the asymmetry constant, and that all the data relative to the size and shape of the virus protein molecule are in good agreement.

An appreciation of the extent to which sols of the virus protein deviate from Fick's law may be obtained from Fig. 1. The data presented were obtained from a

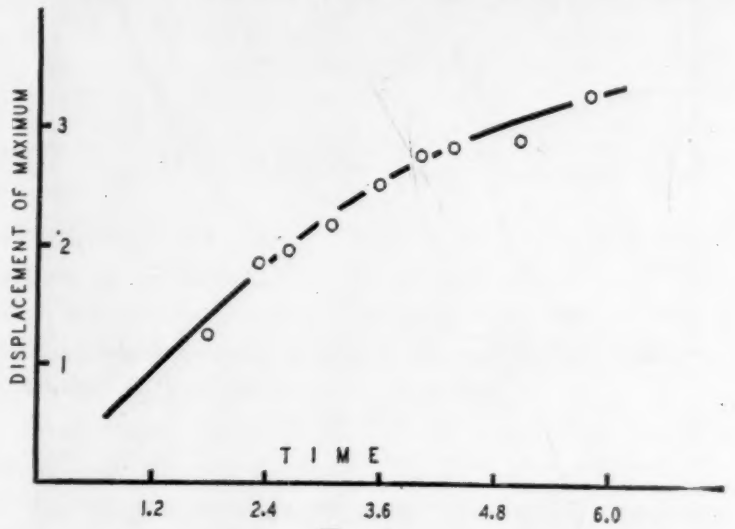

FIG. 1.

diffusion study, using the refractory method of Lamm,[6] of a sol containing .87 per cent. electrodialyzed protein dispersed in distilled water. As has been pointed out,[7,8] the curves obtained by plotting the displacement of the scale lines against the original line positions in the case of the virus protein are skewed, and the point of maximum displacement is shifted toward the solvent side. The rate of drift of the point of maximum displacement is shown in Fig. 1. The abscissa is in 10^5 seconds; the ordinate is in millimeters. The ratio of the distance from the midpoint of the diffusion cell to the lens to the distance from the midpoint of the cell to the scale was .78. Substances that obey the normal laws of diffusion yield curves that are symmetrical with the maximum displacement at the original interface.

The normalized curves deviate markedly from the ideal. The maximum ordinates in normalized coordinates obtained after 1.78 and 5.85×10^5 seconds respectively were .62 and .74. The ordinate of the maximum for the ideal curve

$$y = \frac{1}{\sqrt{2\pi}} \quad e^{\frac{-x^2}{2}}$$

is .40. Following the "maximum height" method of

[1] Eriksson Quensel and T. Svedberg, *Jour. Am. Chem. Soc.*, 58: 1863, 1936.
[2] R. W. G. Wyckoff, S. Biscoe and W. M. Stanley, *Jour. Biol. Chem.*, 117: 57, 1937.
[3] M. A. Lauffer, SCIENCE, 87: 469, 1938.
[4] H. S. Loring, M. A. Lauffer and W. M. Stanley, *Nature*, 142: 841, 1938.
[5] M. A. Lauffer and W. M. Stanley, *Chem. Rev.*, 24: 303, 1939.
[6] O. Lamm, *Zeit. Physik. Chem.*, Abt. A 138: 313, 1928.
[7] V. L. Frampton and A. M. Saum, SCIENCE, 89: 84, 1939.
[8] H. Neurath and A. M. Saum, *Jour. Biol. Chem.*, 126: 435, 1938.

Lamm,[9] in calculating the diffusion constant, and neglecting the viscosity, values of 2.0 and 2.1×10^{-8} were obtained from the initial and final photographs. It seems fair to state, however, that one is justified in calculating the molecular weight of the virus protein from these data, providing he can account for the peculiar diffusion behavior in a quantitative manner.

In Fig. 2, values for the ratio of the short to the

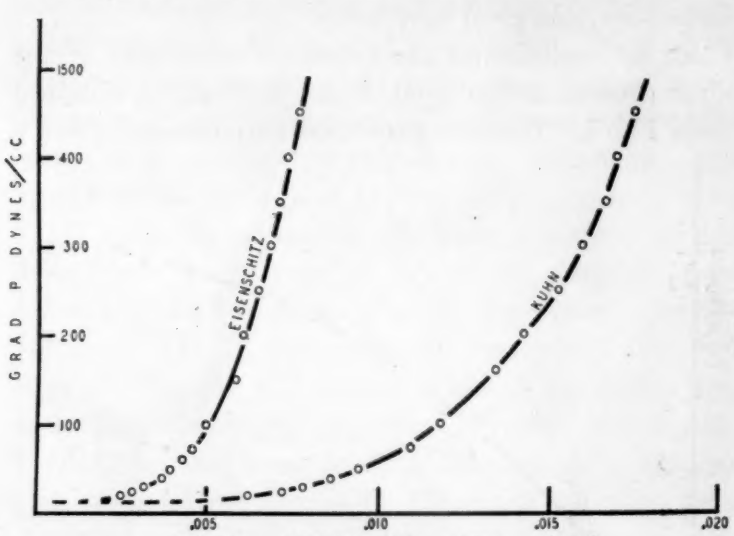

FIG. 2.

long axis of the virus protein at various shearing stresses, as calculated from Frampton's[10] data using the Kuhn and Eisenschitz equations, are plotted against the pressure gradient along the capillary of the capillary viscometer. These two equations may legitimately be used for solutions of elongated particles that obey Poiseuille's law in the case of a random orientation of the particles—ostensibly for a solution at rest. The extrapolated value of the short to long axis is zero; that is, the extrapolated value for the ratio of the long to the short axis for the quiescent fluid is infinite. In the Perrin equation

$$\frac{1}{R} = \frac{\left(\frac{a}{b}\right)^{2/3}}{\sqrt{1-\left(\frac{a}{b}\right)^2}} \log \frac{1+\sqrt{1-\left(\frac{a}{b}\right)^2}}{\frac{a}{b}},$$

where a/b is the ratio of the short to the long axis and R is the asymmetry constant, as a/b becomes smaller and smaller, the value of

$$\frac{\left(\frac{a}{b}\right)^{2/3}}{\sqrt{1-\left(\frac{a}{b}\right)^2}}$$

approaches zero more rapidly than

$$\log \frac{1+\sqrt{1-\left(\frac{a}{b}\right)^2}}{\frac{a}{b}}$$

approaches infinity. That is, in the limit, 1/R is zero, and R is infinite. Substituting the value of R in the well-known equation

$$R = \frac{M(1-\zeta v)}{6\pi\eta_0 N S_{20} \left(\frac{3Mv}{4\pi N}\right)^{1/3}}$$

where M is the molecular weight, we see that in the legitimate use of these methods the corrected value for the molecular weight of the virus protein, as determined by ultracentrifuge means, is infinite. From a similar consideration, the corrected value for the molecular weight as determined by means of diffusion is zero.

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UPWARD TRANSPORT OF MINERALS THROUGH THE PHLOEM OF STEMS

IN 1937 Gustafson and Darken[1,2] showed that radioactive phosphorus was conducted upward in the stem of a plan through the bark. In the second paper it was suggested that to get a quantitative comparison between the conduction in the xylem and the phloem the part of the plant above the cut of xylem or phloem should be ashed and the total activity determined. This has now been done with *Bryophyllum calycinum* and *Salix* sp.

The experiments were conducted as before, except that the activity was determined with a Geiger counter. Usually three plants as alike as it was possible to select were used in each experiment; one was used as control, the second had a section of the xylem removed and the third plant a girdle of bark removed. In some plants the xylem was separated from the bark for a distance of several centimeters, but a piece was not removed, only a cut was made at the lower end of the xylem-phloem separation. The lower end of this bare xylem was kept in a test-tube of water during the experiment to supply the top with an abundance of water, as it was found in some experiments, where a portion of xylem had been removed, that the leaves wilted soon after the experiment was set up.

At the end of the experiment the plants were cut off at the level where the girdle had been made and the two parts ashed separately. The lower part has been designated roots, even though several inches of the base of the stem was included. The ashing was done in a muffle furnace at 650° C.

The ash was dissolved in 10 to 20 ml of 10 per cent. HCl, depending upon the amount of ash. An aliquot (.2 to 1.0 ml, depending upon the activity of the phosphorus) was allowed to be absorbed by a piece of blot-

[9] O. Lamb, *Zeit. Physik. Chem.*, Abt. 143: 177, 1929.
[10] V. L. Frampton, *Jour. Biol. Chem.*, 129: 233, 1939.

[1] F. G. Gustafson and Marjorie Darken, SCIENCE, 85: 482–493, 1937.
[2] F. G. Gustafson and Marjorie Darken, *Amer. Jour. Bot.*, 24: 615–621, 1937.

log paper somewhat smaller than the window over the target of the counter. This piece of blotting paper was then placed on the window over the target. The number of counts were noted for a certain length of time and the counts per minute calculated, and from this was subtracted the background count to give the number of counts due to the plant material. This count per minute was multiplied by the proper factor to obtain the count for all the ash, per minute. The total active phosphorus in the tops or roots was determined only in experiment 37, but as determined the activity in the different parts is strictly comparable and the figures in the table denote the number of counts that would have been observed per minute if all the ash of the particular part of the plant had been placed above the target of the counter.

Table 1 gives the number of beta particles originating in the irradiated phosphorus of the ash that would have hit the target of the Geiger counter per minute if all the ash had been placed above the target.

Table 1 shows clearly that if the top was supplied with water through the cut end of the xylem rather than through the phloem, when the xylem was removed, there was much less phosphorus in the top than when all the water had to pass through the phloem and there was a transpiration stream connecting the top with the root.

The actual amount of active phosphorus in the tops of the plants in experiment 37 was 0.0024 g for the control, 0.0012 g for the plant carrying on conduction

TABLE 1

Plant and experiment number	Hours in solution	Control		Conduction through xylem		Conduction through phloem	
		top	roots	top	roots	top	roots
Bryophyllum							
16	41	310	1020	350	1030	15 (2)	1100
20	48	360	1920	550	990	27 (1, 3)	350
21	48	365	860	447	770	30 (1, 3)	593
22	46	87	548	103	254	20 (1, 3)	684
36	69	6100	6300	4200	4450	375 (3)	5900
37	42	10200	10850	5880	6950	60 (1, 3)	6950
						820 (3)	15400
48	47	.....	.....	1100	2460	500 (1)	2040
Willow							
52	22	195	720	300	810	40 (2, 4)	300
						20 (1, 3)	585
53	48	3060	765	135	345	45 (2)	825
						0 (1, 2)	540
54	7	40	580	112	920	0 (2)	720

Note: (1) Lower end of xylem in a tube of water; (2) leaves wilted badly long before the end of the experiment; (3) partly wilted at end of experiment; (4) plant was in solution only 5 hours.

only through the xylem, 0.0002 g for the plant with phloem as the conduction element and only 0.000014 g when the conduction of the mineral took place through the phloem, but most of the water was supplied to the leaves through the cut end of the xylem.

From these experiments it would seem that not as much minerals are conducted through the phloem as Gustafson and Darken had supposed. Nevertheless, there is undoubtedly some upward conduction of minerals in the phloem under normal conditions.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ACETO-CARMINE METHOD FOR BIRD AND MAMMALIAN CHROMOSOMES

EXCELLENT aceto-carmine preparations, either temporary or permanent, can be made of bird and mammalian chromosomes (and no doubt of other animals) by the simple procedure described below. The method is applicable to any tissue which can be readily subdivided by teasing with needles prior to fixation.

The tissue—usually young embryos, embryonic ovary or adult testis—is removed with the greatest possible speed and with the usual precautions to insure that the cells are living and normal, and quickly dissociated by teasing with needles for four or five seconds and then plunged in one of Carnoy's fixatives, where it can be further teased apart. Both the 3:1 and 6:3:1 solutions give excellent results with bird embryo somatic cells and ovaries, and with adult rat testes. (3 parts absolute alcohol and 1 part of glacial acetic acid, or 6 parts of absolute alcohol, 3 parts of chloroform and 1 part of glacial acetic acid.)

The tissue is fixed for 20 minutes to several hours and then placed directly into aceto-carmine, where it should stain for half an hour, more or less, depending on the tissue. *Small* bits of tissue are next removed with a pipette, along with aceto-carmine, and placed on a clean slide and covered with a coverglass. The preparation is now treated just as you would a salivary gland. The excess aceto-carmine is blotted off with filter paper and the soft tissue mashed out with considerable pressure from the finger tips. If necessary, complete spreading of the cells may be accomplished by rubbing a blunt needle over the coverglass. During this whole process the coverglass must not be allowed to slip about. For temporary mounts, the coverglass is sealed with vaseline or some other like agent and studied at once. For permanent slides the coverglass is left unsealed and the slide is placed at once into a jar saturated for alcohol vapor. (This is Bridges's alcohol-euparal method.) After standing in alcohol fumes for a few hours, the slides are placed in 95 per cent. alcohol, where they should remain for several hours or longer. If the coverglass doesn't loosen and come off it should be pried off with a spade-shaped needle in a Petri dish filled with 95 per cent. alcohol. When this is done part of the cells adhere to

the slide, others to the coverglass and some are lost, especially when too much tissue was used in the first place. The slide is next removed from the Petri dish, the excess alcohol quickly drained or wiped off, and the adhering tissue is covered at once with a liberal amount of euparal or its equivalent. Next the excess alcohol is drained from the coverglass and the latter is placed back on the slide, face down and in its original position. Excess euparal is blotted off and after shifting the coverglass to as near its original position as possible, the preparation is ready for study.

The advantage of the method is its simplicity and speed and the excellent preservation and staining of the chromosomes. Meiotic chromosomes are especially well shown in the rat. The alcoholic-acetic fixation leaves the tissue so soft its cells can be separated by mashing after staining with aceto-carmine. The other preliminary fixatives tried so far (Flemming, Nawaschin, etc.) leave the tissues too hard or tough to be mashed out.

In studying any aceto-carmine preparation it is desirable to use green filters, Wratten filters Nos. 61 and 62 being especially recommended with artificial light. In a pinch, a piece of green eye-shade will do.

T. S. PAINTER

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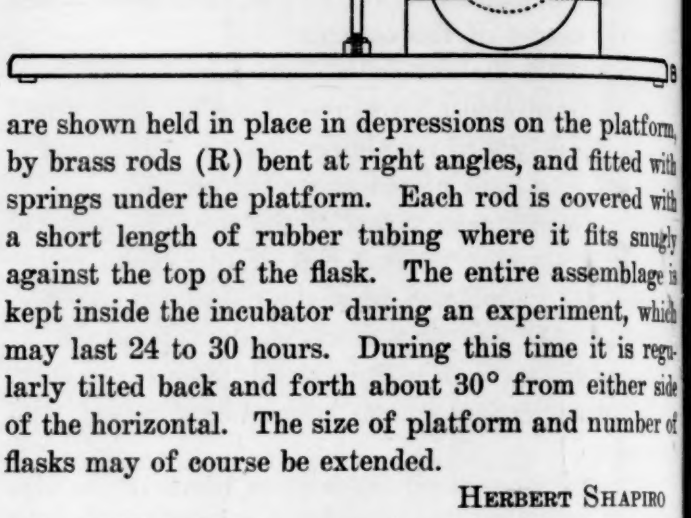
A SIMPLE ROCKING DEVICE FOR CARREL FLASKS[1]

IN experiments on the artificial parthenogenesis and development of rabbit eggs *in vitro,* we have usually placed the eggs in rabbit serum in a Carrel flask and left them stationary in an incubator at 37.5° C. When the eggs are removed from the Fallopian tubes within 15 hours after the final ovulating injection of pituitary has been given, each one is found covered by several layers of granulosa cells adhering closely to the protein layer immediately surrounding the egg, and the eggs as a whole are embedded in a much larger mass of loose material of similar nature. While standing in the incubator, these cells tend to fall away from the eggs, disintegrate and spread over the bottom of the flask. While this in itself may not be deleterious, it appears to be instrumental in causing the eggs as well to adhere to the glass substratum. To avoid this, we have found the shaker, of which a side elevation is sketched in the accompanying figure, to be of definite value. Not only does it in general prevent the sticking and disintegration of this material, referred to above, but it assists the adequate and uniform oxygenation of the culture, and helps prevent local accumulation of carbon dioxide. On the whole, the condition of the eggs is definitely an improvement over that when they are left stationary. It may be of use also in oxygenating tissue cultures with large quantities of fluid, which adhere firmly after an initial growth period.

The construction is simple. On a baseboard (B), 42 × 20 cm a Telechron motor (T), giving four revolutions per minute, is mounted and attached by a 10 cm shaft (S) on the eccentric to the platform P, 8.5 × 25.5 cm, and 15 cm above the base. Seven Carrel flasks (C)



are shown held in place in depressions on the platform, by brass rods (R) bent at right angles, and fitted with springs under the platform. Each rod is covered with a short length of rubber tubing where it fits snugly against the top of the flask. The entire assemblage is kept inside the incubator during an experiment, which may last 24 to 30 hours. During this time it is regularly tilted back and forth about 30° from either side of the horizontal. The size of platform and number of flasks may of course be extended.

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